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Range Plant Communities and Range Health Assessment Guidelines for the Dry Mixedgrass Natural Subregion of Alberta

Dry Mixedgrass

Range Plant Community Guide

Alberta
SUSTAINABLE RESOURCE DEVELOPMENT
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For additional copies contact:

Barry W. Adams P. Ag.
Range Management Specialist
Rangeland Management Branch
Public Lands and Forests Division
Alberta Sustainable Resource Development
Agriculture Centre, #100, 5401 - 1 st Ave South
Lethbridge, Alberta, T1J 4V6.
<barry.adams@gov.ab.ca>
ph 403 382-4299 cell 403-308-9946 fax: 403 381-5792

On the Web:

Rangeland plant community guides are available on our website at:
< http://www3.gov.ab.ca/srd/land/publiclands/range.html>

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RANGE PLANT COMMUNITIES AND RANGE HEALTH ASSESSMENT GUIDELINES FOR THE DRY MIXEDGRASS NATURAL SUBREGION OF ALBERTA

First Approximation

Pub. No. T/040

May 2005

Prepared by:

Barry W. Adams, Lindsay Poulin-Klein and Darlene Moisey

and

Ron L. McNeil
LandWise Inc., Lethbridge, AB

Alberta Sustainable Resource Development
Rangeland Management Branch, Public Lands and Forests Division
Lethbridge, Alberta

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Executive Summary

The Dry Mixedgrass Natural Subregion is a zone of transition between the Great Plains and fescue grasslands of the Foothills Fescue and Foothills Parkland Natural Subregions. The Dry Mixedgrass accounts for 47.5% of the Grassland Natural Region area, and 7% of the area of Alberta. Approximately 43% of the original 11.8 million acres of Dry Mixedgrass prairie remain today.

This, and other plant community guides in the series, replace the original Guide to Range Condition and Stocking Rates for Alberta Grasslands by Wroe et al. (1988). The guide is designed for use with the field workbook - Range Health Assessment for Grassland, Forest and Tame Pasture (Adams et al. 2003). A new feature of this guide is a soil correlation mechanism that provides more guidance in determining range site, an important link to range plant communities. The guide should be used with published soil survey information or AGRASID (Agricultural Regions of Alberta Soil Information Database). Other site information like landscape, soil features and textural groupings will aid in range site determination.

Relevant grazing research is summarized especially from the Agriculture and Agri-Food Research Substation at Manyberries. Past range plant community studies are also reviewed.

This first approximation will address the most extensive and common grassland and shrub plant communities in Dry Mixedgrass. The analysis evaluated 1716 vegetation plots and distinguished 45 plant communities all of which were native grassland or shrub types. Plant communities are reported in three categories. The reference plant communities are considered to represent the potential natural community for the site in question. Native successional plant communities are identified in relation to the reference plant community. These communities reflect the impact of variation in frequency and intensity of disturbance to the reference plant community. No modified (dominated by non-native species) communities were identified in this first approximation. Ecologically sustainable stocking rates are provided for each plant community type. Future studies will address riparian plant communities and other range sites of lesser extent on the landscape. The report also includes consolidated guidelines and scoring notes for range health assessment in the Dry Mixedgrass.

Contributors

Special thanks are extended to Dennis Milner who provided valuable stocking rate histories for a variety of plant community types in the Dry Mixedgrass. Other contributors also include Nancy Boutillier, Jennifer Carlson, Bruce Cairns, Lynn Fitzpatrick, Terry Hood, Tracy Kupchenko, Ken Pitcher, Jake Willms, Alberta Sustainable Resource Development; Clare Tannas, Eastern Slopes Rangeland Seeds; Alan Robertson, High Range Ecological Consultants; Varge Craig, Alta Rangeland Services.

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We wish to acknowledge Michael Willoughby, ASRD, Edmonton, for his leadership in the development of range plant community classifications for a significant portion of Alberta's rangelands. We also wish to express our sincere thanks for his council and assistance on methods and procedures.

Development of plant community guides for the grassland natural region has been possible because of the large and growing body of high quality vegetation plot data collected by Range Management program staff and a number of rangeland consultants since 1986 when the Southern Range Inventory project was established, primarily to collect range plant community information for management planning. These professionals have payed particular care and attention to accurate plant taxonomy and consistent application of inventory methods. We wish to acknowledge the high quality of range vegetation inventory data that has been collected for the Public Lands Division by Kathy and Clare Tannas (Eastern Slopes Rangeland Seeds, Cremona, AB), Alan Robertson (High Range Ecological Consultants, Edmonton, AB) and Bryne Weerstra (Biota Consultants, Cochrane, AB). Thanks also to Brenda Chmielewski, ASRD, Lethbridge, who aided in the preparation of the manuscript.

I wish to acknowledge the ongoing council, encouragement and friendship provided by Dr. Walter Willms and Dr. John Dormaar, Agriculture and Agri-Food Canada, Lethbridge.

Comments on the First Approximation

The first approximation is provided to define the major native grassland communities and a limited number of shrub communities for the Dry Mixedgrass Natural Subregion. This will provide an initial plant community guide with basic standards for assessing range health using the new range health assessment protocol (Adams et. al 2003). The first-approximation guides in the grassland natural region provide plant community information in a similar format to the plant community guides developed by Willoughby et. al (2003) for Boreal and Rocky Mountain natural regions thus ensuring a more standardized format province wide.

A new feature of guides in the grassland natural region will be an improved framework for correlating soils information to range site and plant community. A strength of the original stocking guide (Smoliak et. al 1966, Wroe et. al 1988) was the use of generic range sites definitions that allowed users to recognize site potential. The new system builds on the old framework but provides more objectivity in determining range site.

Recently Thompson and Hansen (2002) have classified riparian and wetland plant communities in the grassland natural region. The 2nd approximation will integrate this information with the range plant communities described here. Additional research is required beforehand to permit correlation with more specific soils information.

USING THE GUIDE - MAJOR TOPICS

Determining Ecological Range Sites

To use this plant community guide, you will need information about the dominant and subdominant soils for the landscape you are interested in within the Dry Mixedgrass Natural Subregion. Identification of the potential natural community (or reference plant community) for a site begins by recognizing the ecological range site. Range site is identified through **key attributes of the landscape**, **soil features** and by **textural groupings**.

Important! - Review the reference materials identified in this chapter, especially AGRASID 3.0[1] (Agricultural Regions of Alberta Soil Information Data Base)

Chapter 2.0 provides a detailed review of physiography, climate and soils of the Dry Mixedgrass Natural Subregion:

- General overview of physiography, climate and soils in the Dry Mixedgrass....................page 3
- General definitions for ecological range sites - Appendix 9.1....................page 98
- Correlation of soils and ecological range sites ....page 10
- Procedure for determining range sites ....page 17
- See Appendix 9.2 A Concise Guide to Assist Users of AGRASID....................page 100

Review of Literature

Previous grazing studies and plant community studies are reviewed in chapters 3 and 4 of the report:

- Grazing research in the Mixedgrass and Dry Mixedgrass ....page 21
- Previous plant community studies in the Dry Mixedgrass....................page 25

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[1] To obtain a copy of AGRASID 3.0 got to: http://www.agric.gov.ab.ca/soil/agrasid/agrasidmainpage.html

Range Plant Communities and Suggested Carrying Capacities

The KEY to range plant communities is on the following page.
Chapter 6 is the core chapter describing range plant communities within the Dry Mixedgrass, their successional relationships, suggested carrying capacities and detailed plant community descriptions:

- Summary table of reference, successional and modified plant communities ....pages 32-35
- Summary of range plant communities and suggested carrying capacities ....page 36-39
- Description of **native grassland communities** ....pages 40-78
- Description of **shrub communities** ....pages 79-84

Guidelines for Assessing Range Health in the Dry Mixedgrass Natural Subregion

- Guidelines for assessing ecological status, plant community structure, soil exposure, litter abundance and noxious weeds in the Dry Mixedgrass Natural Subregion ....pages 85

Key to Range Plant Communities

Plant Community Categories

1. Plant community is in the Dry Mixedgrass subregion, is dominated by native grasses and grasslike species, and if shrub species are present, the canopy cover of the dominant shrub species is less than 5% .... **Native Grassland Key**
   Plant community is in the Dry Mixedgrass subregion and the canopy cover of the dominant shrub species is 5% or greater.................... **Shrub Community Key**

Native Grassland Key

1. Native grasslands with a cover of silver sagebrush of greater than 1 % and up to 5% 2
   Native grassland where either silver sagebrush is not present, or if present, has a canopy cover of 1% or less, and where the dominant grass is western porcupine grass, northern or western wheatgrass, needle-and-thread grass, blue grama grass, Sandberg bluegrass, salt grass or low sedge 11
2. Native grassland with greater than 1 % and up to 5% sagebrush and dominant grass species is needle-and-thread grass....................3
   Native grassland with greater than 1 % and up to 5% sagebrush and dominant grass species is northern or western wheatgrass, or sandberg bluegrass....................8
3. Dominant grass species include needle-and-thread grass and blue grama grass 4
   Dominant grass species include needle-and-thread grass, and sandgrass or wheatgrasses as the subdominant grass species 7
4. Dominant grass species include needle-and-thread grass and blue grama grass and is a loamy or sandy range site 5
   Dominant grass species include needle-and-thread grass and blue grama grass and is a shallow-to-gravel or gravel range site 6
5. Native grassland is a loamy range site....................
   ....**Silver Sagebrush/Needle-and-Thread - Blue Grama Grass DMGA12**
   Native grassland is a sands range site....................
   ....**Silver Sagebrush/Needle-and-Thread-Blue Grama Grass-June Grass DMGA18**
6. Native grassland is a shallow-to-gravel range site....................
   ....**Silver Sagebrush/Needle-and-Thread-Blue Grama Grass-June Grass DMGA37**
   Native grassland is a gravel range site....................
   ....**Silver Sagebrush/Needle-and-Thread-Blue Grama Grass-June Grass DMGA23**
7. Dominant grass species include needle-and-thread and western wheatgrass on a limy range site........**Silver Sagebrush/Needle-and-Thread-Western Wheat Grass-Blue Grama Grass DMGA24**
   Dominant grass species include needle-and-thread and sand grass on a sands range site....................**Silver Sagebrush/Needle-and-Thread-Sand Grass DMGA19**
8. Dominant grass species include either northern or western wheatgrass 9
   Dominant grass species is Sandberg bluegrass on a blowout range site
   ....**Silver Sagebrush/Sandberg Bluegrass-June Grass DMGA31**
9. Dominant grass species include northern and western wheatgrass with Nuttall's atriplex and is a saline lowland range site....................**Silver Sagebrush/ Wheatgrass - Nuttall's Atriplex DMG A21**
   Dominant grass species are northern or western wheatgrass on a blowout range site 10
10. Dominant grass species are wheatgrasses and sandberg bluegrass ....
    ....**Silver Sagebrush/Northern Wheat Grass - Sandberg Bluegrass DMGA39**
    Dominant grass species are wheatgrasses, June grass and blue grama grass ....
    ....**Silver Sagebrush/Northern Wheat Grass - June Grass-Blue Grama Grass DMGA34**
11. Dominant grass is a low growing species like blue grama, sandberg bluegrass, saltgrass or low sedge....................12
    Dominant grass is a mid-grass species such as western porcupine grass, northern or western wheatgrass or needle-and-thread grass....................17
12. Dominant grass species is blue grama grass 13

Dominant grass species is low sedge, Sandberg bluegrass or salt grass 15

13. The blue grama dominated plant community is on a badland range site...**Blue Grama Grass-Salt Grass-Needle-and-Thread DMGA36**

The blue grama dominated community is on a loamy range site 14

14. The plant community is a seral community dominated by blue grama and needle-and-thread grass and is on a moist loamy range site ....**Blue Grama - Needle-and-Thread DMGA48**

The plant community is a seral community dominated by blue grama and needle-and-thread grass on a typical loamy range site ....**Blue Grama - Needle-and-Thread DMGA10**

15. The plant community is a seral plant community dominated by low sedge and western wheatgrass on an overflow range site......................... **Low Sedge-Western Wheatgrass-Green Needle Grass DMGA41**

Plant community is dominated by Sandberg bluegrass or saltgrass...16

16. The plant community is dominated by Sandberg bluegrass and northern or western wheatgrass on a blowout range site..**Sandberg Bluegrass-Northern Wheat Grass DMGA30**

The plant community is dominated by salt grass and northern or western wheatgrass on a saline lowland range site..**Salt Grass - Western Wheatgrass DMGA44**

17. The dominant native grass species is western porcupine grass 18

The dominant native grass species is northern and western wheatgrass or needle-and-thread grass.......19

18. The plant community is a late seral plant community dominated by western porcupine grass on an overflow range site...................**Snowberry/Western Porcupine Grass - Needle-and-Thread DMGA1**

The plant community is a later seral plant community dominated by western porcupine grass, needle-and-thread grass and sand grass on a sandy range site ....**Western Porcupine Grass-Needle-and-Thread-Sand Grass DMGA13**

19. The dominant grass species is northern or western wheatgrass...20

The dominant grass species is needle-and-thread grass 26

20. The plant community is dominated by northern or western wheatgrass and subdominant grass is needle-and-thread grass 21

The plant community is dominated by northern or western wheatgrass and subdominant graminoid is low sedge, salt grass or a disturbance forb species like fringed sage 22a

21. The plant community is western wheatgrass and needle-and-thread, on a sandy range site.. **Western Wheat Grass - Needle-and-Thread DMGA14**

The plant community is dominated by western wheatgrass and needle-and-thread grass, on a blowout range site...**Wheat Grass-Needle-and-Thread-June Grass DMGA15**

22a.The plant community is dominated by western wheatgrass and low sedge 22

The plant community is dominated by western wheatgrass and Sandberg bluegrass, saltgrass or pasture sagewort...24

22. The plant community is dominated by western wheatgrass and low sedge, on a saline lowland or overflow range site..23

The plant community is dominated by western wheatgrass and low sedge, on a blowout range site...**Western Wheat Grass-Sedge-Needle-and-Thread DMG16**

23. The plant community is dominated by western wheatgrass and low sedge, on a saline lowland range site.. **Western Wheat Grass-Sedge DMGA20**

The plant community is dominated by western wheatgrass and low sedge, on an overflow range site...**Western Wheatgrass-Low Sedge-Green Needle Grass DMGA40**

24. The plant community is dominated by western wheatgrass and Sandberg bluegrass and is a blowout range site ....**Wheatgrass - Sandberg Bluegrass DMGA39**

The plant community is dominated by western wheatgrass and Salt grass or pasture sagewort and is a overflow or clayey range site...25

25. The plant community is dominated by western wheatgrass and salt grass and is a disturbed overflow range site .... **Western Wheat Grass - Salt Grass - Gumweed DMGA45**

The plant community is dominated by western wheat grass on a clayey range site.. **Western Wheat Grass-Pasture Sagewort-Prickly Pear Cactus DMGA8**

26. The plant community is dominated by needle-and-thread grass and northern or western wheatgrass 27

The plant community is dominated by needle-and-thread grass with other subdominant grasses 28

27. The plant community is dominated by needle-and-thread grass and northern or western wheatgrass and is a moist loamy range site ....**Needle-and-Thread - Wheatgrass DMGA2**

The plant community is dominated by needle-and-thread grass, northern wheatgrass and plains reed grass and is a typical loamy range site .... **Needle-and-Thread - Northern - Wheatgrass - Plains Reed Grass DMGA5**

28. The plant community is dominated by needle-and-thread grass and upland sedge species **29**
    The plant community is dominated by needle-and-thread grass and other grasses or forms are subdominant **30**
29. The plant community is dominated by needle-and-thread grass and thread leaved sedge and is a moist loamy range site..**Needle-and-Thread - Thread-leaved Sedge DMGA9**
    The plant community is dominated by needle-and-thread grass, low sedge and sand grass, on a sands range site ....**Needle-and-Thread- Low Sedge-Sand Grass DMGA43**
30. The plant community is dominated by needle-and-thread grass with blue grama grass as the subdominant species **31**
    The plant community is dominated by needle-and-thread and June grass, Sandberg bluegrass, pasture sagewort or wild licorice as the subdominant species **34**
31. The plant community is dominated by needle-and-thread grass and blue grama grass and is a seral plant community on a moist loamy range site **32**
    The plant community is dominated by needle-and-thread grass and blue grama grass on a thin breaks range site **33**
32. The plant community is dominated by needle-and-thread and blue grama grass with a significant cover of wheatgrasses on a moist loamy range site ....**Needle-and-Thread - Blue Grama - Wheatgrass DMGA46**
    The plant community is dominated by needle-and-thread and blue grama grass with a minor cover of northern or western wheatgrass on a moist loamy range site ....**Needle-and-Thread - Blue Grama -Northern-Wheatgrass DMGA47**
33. The plant community is dominated by needle-and-thread, blue grama grass and low sedge on a thin breaks range site ....**Needle-and-Thread-Blue Grama - Low Sedge DMGA42**
    The plant community is dominated by needle-and-thread, blue grama grass and June grass on a thin breaks range site ....**Needle-and-Thread-Blue Grama Grass-June Grass DMGA22**
34. The plant community is dominated by needle-and-thread and June grass **36**
    The plant community is dominated by needle-and-thread and Sandberg bluegrass, pasture sagewort or wild licorice **37**
36. The plant community is dominated by needle-and-thread grass, June grass and blue grama grass on a loamy range site .... **Needle-and-Thread - June grass - Blue Grama Grass DMGA3**
    The plant community is dominated by needle-and-thread grass, June grass and blue grama grass on a blowout range site.............................. **Needle-and-Thread-June Grass-Blue Grama Grass DMGA35**
37. Plant community is dominated by needle-and-thread grass and pasture sagewort **38**
    Plant community is dominated by needle-and-thread grass and Sandberg bluegrass or wild licorice.....**39**
38. Plant community is dominated by needle-and-thread grass and pasture sagewort and is a gravel range site ....**Needle-and-Thread-Pasture Sagewort DMGA33**
    Plant community is dominated by needle-and-thread grass and pasture sagewort and is a shallow-to-gravel range site ....**Needle-and-Thread-Pasture Sagewort DMGA38**
39. Plant community is dominated by needle-and-thread grass and Sandberg bluegrass on a blowout range site ....**Needle-and-Thread - Sandberg Bluegrass DMGA17**
    Plant community is dominated by needle-and-thread and wild licorice on a choppy sandhill or sands range site ....**Needle-and-Thread-Wild Licorice DMGA32**

Shrub Community Key

1. Shrub community is a dominated by silver sagebrush..**2**
   Shrub community is dominated by common wild rose, snowberry, creeping juniper, greasewood or chokecherry **3**
2. Plant community is dominated by silver sagebrush and northen or western wheatgrass and is a saline overflow ....**Silver Sagebrush/ Western Wheatgrass DMGC1**
   Plant community is dominated by silver sagebrush and western porcupine grass and is a non to low salinity overflow range site ....**Silver Sagebrush/Western Porcupine Grass-Wheatgrass DMGC3**

3. Shrub community is a dominated by creeping juniper and is a located in the Manyberries Badlands ....**Creeping Juniper/Undifferentiated Sedge DMGC4**
   Shrub community is dominated by common wild rose, snowberry, greasewood or chokecherry 4
4. Shrub community is a dominated by greasewood and is an overflow or badland range site..........**Greasewood/ Salt Grass - Western Wheat Grass DMGC7**
   Shrub community is dominated by common wild rose, snowberry or chokecherry..........5
5. Shrub community is dominated by wild rose and is a choppy sandhills range site..........**Wild Rose/Needle-and-Thread-Sand Grass-Low Sedge DMGC5**
   Shrub community is dominated by chokecherry and is a choppy sandhills range site..........**Choke Cherry/Northern Wheatgrass-June Grass DMGC6**

1.0 Introduction and Background

1.1 This Guide - An Aide to Rangeland Health Assessment

This plant community guide is provided as an essential reference for range health[2] assessment in the Dry Mixedgrass Natural Subregion of Alberta. Range health assessment (Adams et al. 2003) is a new approach that builds on the traditional range condition concept that considers plant community type in relation to site potential, but also adds new indicators of important natural processes and functions.

Range management strives to protect and enhance the soil and vegetation complex while maintaining or improving the output of consumable products along with a wide range of other values and natural functions. Ranchers and resource managers have used the concept of range condition in Alberta to measure any deterioration that has taken place within a range plant community due to disturbances especially from livestock grazing. Range condition has been rated in relation to a concept of site potential or climax vegetation. The first stocking guide for the grassland natural region The Guide to Range Condition and Stocking Rates for Alberta Grasslands, was patterned after the US Department of Agriculture - Soil Conservation Service "range site" concept (Smoliak et al. 1966, Wroe et al. 1988). Since the first guide was published, several generations of ranchers and range resource managers have developed an understanding of range sites and the ecological conditions that they represent. The new range health tools are similarly intended for use by range resource managers and rancher and for a wide variety of other groups and users that share an interest in healthy rangelands.

Range managers generally strive to maintain plant communities in late seral or higher successional stages (e.g. climax or potential natural community (PNC)), in order to provide higher levels of ecological functioning and to sustain an optimum flow of products like livestock forage. Healthy range plant communities perform important ecological functions and provide a broader suite of goods and services than lower seral stages. Early and mid seral stages need to be present in the landscape to represent the full range of natural variation that existed prior to European settlement, but should not be predominant.

Our use of the term "range health" instead of "range condition" flags a change in approach that builds on the traditional range condition concept. The new approach also considers plant community type in relation to site potential, but adds new indicators of natural processes and functions, important functions performed by healthy rangelands. We use the term range health to mean the ability of rangeland to perform certain ecological functions. These functions include:

---

[2] The range health approach is being adopted in the United States and Canada by a variety of agencies and organizations including the Natural Resource Conservation Service (NRCS), the US Forest Service and the Bureau of Land Management (Butler et al 1997, Busby et al 1994, and Task Group on Unity in Concept and Terminology 1995). The Alberta Rangeland Health Assessment project will provide new rangeland monitoring tools for Alberta rangelands (Willoughby et al. 1999).

- net primary production,
- maintenance of soil/site stability,
- capture and beneficial release of water,
- nutrient and energy cycling and,
- plant species functional diversity.

Healthy rangelands will provide sustainable grazing opportunities for livestock producers and also sustain a long list of others products and values. Declines in range health will alert the range manager to the need for management changes.

1.2 *Ecological Range Sites and Grassland Plant Communities*

Range health is measured by comparing the functioning of ecological processes on an area of rangeland to a standard known as an **ecological site description**. An **ecological site** is similar to the concept of **range site**, but a broader list of characteristics are described. *An* ***ecological site*** *as defined by the Task Group on Unity and Concepts (1995), "is a distinctive kind of land with specific physical characteristics that differs from other kinds of land in its ability to produce a distinctive kind and amount of vegetation".* This is similar to the ecosite/ecosite phase concept described by Beckingham and Archibald (1996) largely applied in the forested portions of the Rocky Mountain, Foothill and Boreal Forest natural regions where forest cover provides a valuable aide to community classification.

Ecological classification systems are an important tool for resource managers (Beckingham and Archibald 1996, Willoughby et. al 2003) and they:

- help us to organize what we know about ecosystems,
- provide resource managers with a common language for range resource management and planning,
- facilitate ecologically based decision making,
- help us to understand and refine resource potentials and carrying capacities over time.

Early grassland studies in the 1940's and 1950's (Clark et. al 1943, Coupland 1950, 1961) provided a broad and generalized understanding of prairie grassland communities, but a comprehensive classification of Alberta grassland natural region has never been completed. An ecological classification system must provide a method for identifying site potential and to help predict where a particular plant community is likely to occur in the landscape. In a forest setting, forest canopy provides important evidence of growing conditions and site potential. In grassland environments, soils information is essential to predicting the potential natural community especially where disturbance history may limit the resource managers understanding of the ecological status of the current plant community vs. the potential for the site. **In range health assessment, we refer to the plant community that is an expression of site potential as the reference plant community (RPC) since this is the community that acts as a standard for comparison in range health assessment.**

With the development of AGRASID (Agricultural Region of Alberta Soil Inventory Database, ASIC 2001), it is possible to establish site and soil characteristics within an acceptable degree of accuracy from the AGRASID digital soils data base, for lands in the agricultural settlement area of the province. The soil/range site correlation tables developed by LandWise Inc. (1998, 2001), provide a crosswalk that allows users to apply information about soils and other landscape variables to establish range sites. Ecological range site descriptions are used to predict reference plant communities.

Grassland plant communities are defined in an ecological classification system in a similar fashion to forest communities by grouping vegetation data (from research plots and range surveys) "into similar functional units that respond to disturbance in a similar and predictable manner (Beckingham and Archibald 1996)". In the classification process that we use in this project, we begin by correlating recognizable plant communities with a broad range site definitions, like Loamy, Overflow or Blowout. If more than one plant community is correlated with a given range site type, we then make further subdivisions of the range site type based on variability within the range site definition. For example, over the breadth of a natural subregion, the variation in Loamy soils might be further subdivided on variation in temperature and precipitation which in turn is reflected in the plant community. Loamy sites near the moist end of the natural subregion might be described as Loamy 1 and the driest in the sequence would be Loamy^n An **ecological range site** then would be the combination of the plant community name and the subdivsion of the range site (e.g. Loamy 1 - Needle-and-thread- Thread Leaved Sedge).

The plant communities presented in this report represent the first approximation for the Soil Correlation Area 1 (SCA 1) and the Dry Mixedgrass Natural Subregion and will be further revised and refined with additional plant community studies.

2.0 Physiography, Climate and Soils of the Dry Mixedgrass Natural Subregion

2.1.1 Overview

The Dry Mixedgrass Natural Subregion is one of four Natural Subregions in the Grassland Natural Region (Achuff 1994), along with the Mixedgrass, Foothills Fescue, and Northern Fescue (Fig. 1). The Dry Mixedgrass accounts for 47.5% of the Grassland Natural Region area, and 7% of the area of Alberta (ASIC 2001). Approximately 43% of the original 11.8 million acres of Dry Mixedgrass prairie remain today.

The Dry Mixedgrass Natural Subregion occurs in southeastern Alberta, from the Montana border north to the Oyen region, and from the Saskatchewan border west to a line trending from Warner, north through Lomond, Bassano, and Hanna (Fig. 1). The only areas of the southeastern corner of Alberta that do not belong to the Dry Mixedgrass are the highlands associated with the Sweetgrass Upland and Cypress Hills, and an isolated upland block north of Oyen (Fig. 1).

The boundaries of the Dry Mixedgrass Natural Subregion correspond closely to the boundaries of the Agricultural Regions of Alberta Soil Information Database (AGRASID) Soil Correlation Area (SCA) 1 (Fig1).

The Mixedgrass Natural Subregion includes 15 Ecodistricts[3], which are: Wildhorse Plain, Foremost Plain, Purple Springs Plain, Vauxhall Plain, Bow City Plain, Brooks Plain, Berry Creek Plain, Sounding Creek Plain, Sibbald Plain, Oyen Plain, Acadia Valley Plain, Bindloss Plain, Rainy Hills Upland, Schuler Plain, and the Cypress Slope adjacent to the Cypress Hills (Fig. 2)

The Dry Mixedgrass is dominated by Brown Chernozemic and Solonetzic soils (Table 1). Parent materials are dominantly glacial till. Topography is dominantly undulating, and hummocky topography is secondary (Fig. 3).

Drainage in the Dry Mixedgrass Natural Subregion occurs via the following major basins, which are from south to north:

- Milk River - drains south and east to the Gulf of Mexico via the Missouri and Mississippi rivers;
- South Saskatchewan - drains to Hudson Bay. The Oldman, Bow, and Red Deer Rivers all drain to the South Saskatchewan River; and
- Sounding Creek - drains to an internal basin in west-central Saskatchewan.

There are several smaller internally-drained basins, the largest of which are Pakowki Lake, Many Island Lake, Tide Lake, and Sullivan Lake.

The Dry Mixedgrass Natural Subregion reflects conditions that are drier and warmer in summer compared with bordering Natural Subregions (Table 1).

Table 1. Key distinguishing features of the Dry Mixedgrass Natural Subregion compared with bordering Natural Subregions.

Natural Subregion	**Dominant Soils**	**Dominant Vegetation**	**General Climate compared to Dry Mixedgrass**
Dry Mixedgrass	Brown Chernozemic	Blue grama and Needle and Thread grass	
Mixedgrass	Dark Brown Chernozemic	Wheat grasses and Needle and Thread grass.	Moister, with warm summers. About 20 to 30 more days with Chinooks. Precipitation higher by 20% (Achuff 1994).
Northern Fescue	Dark Brown Chernozemic and Dark Brown Solonetzic	Rough Fescue	Colder, more continental, fewer Chinooks

Note: Values are averages based on the reported stations.

Landscapes in the Dry Mixedgrass Natural Subregion are mainly nearly level, undulating, and low-relief hummocky. Land use is mainly devoted to a mix of crop agriculture and native range. Extensive areas of native range occur in the southeastern, central and northern areas (Fig. 2).

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[3] Ecodistricts are based on distinct physiographic and/or geologic patterns. They are distinguished by similar patterns of relief, geology, geomorphology and genesis of parent material.

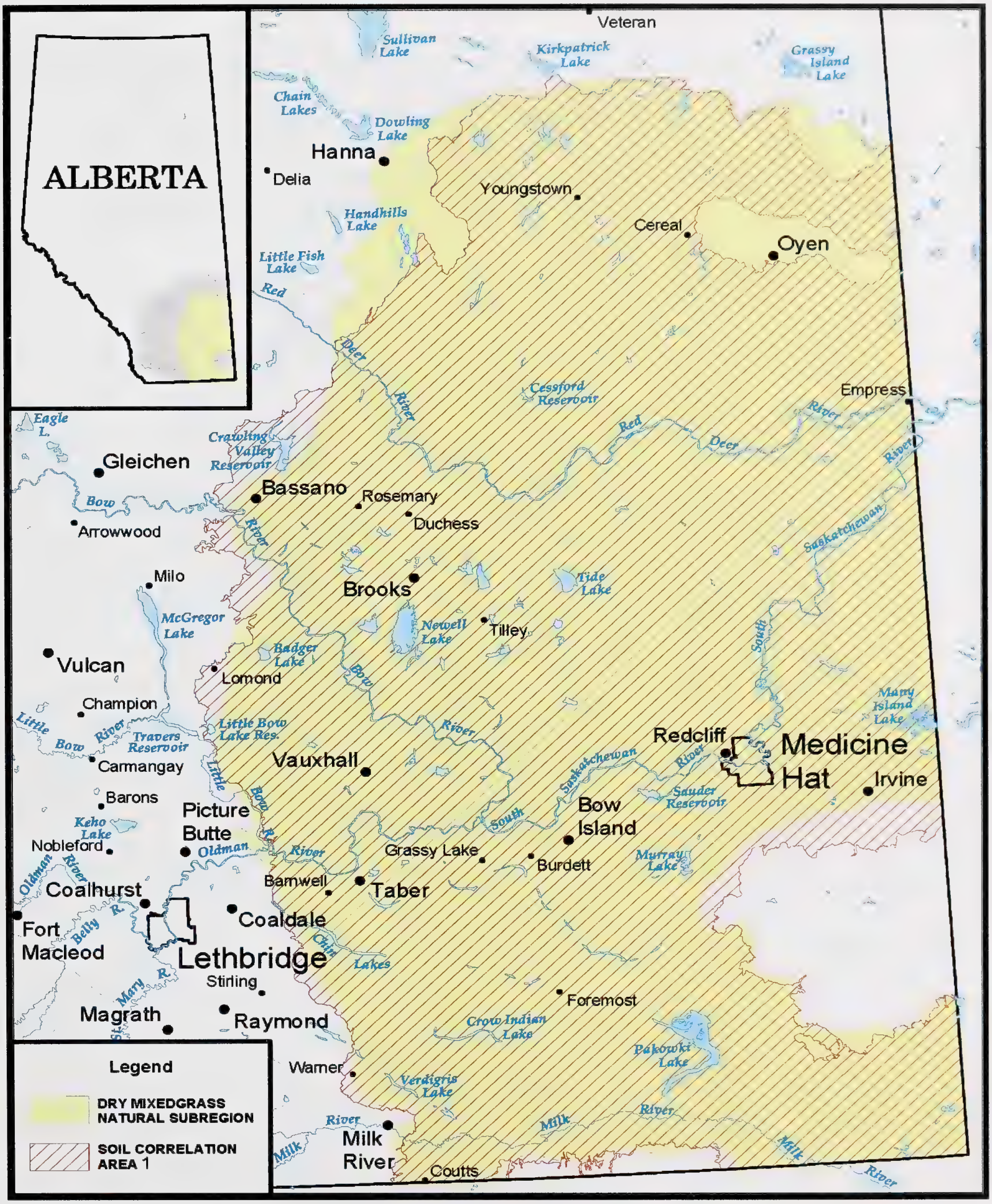

Figure 1: Dry Mixedgrass Natural Subregion in Relation to Soil Correlation Area 1

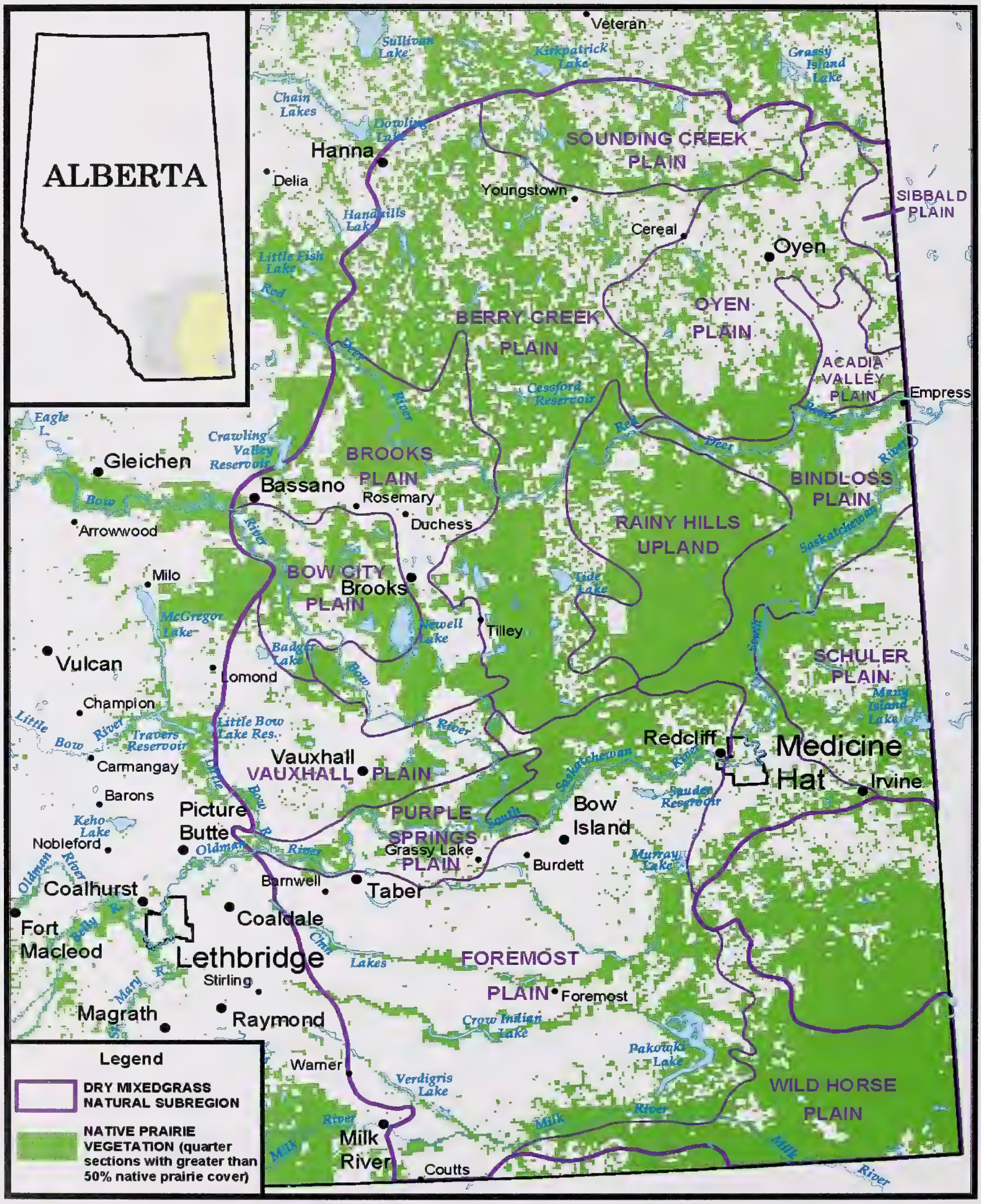

Figure 2: Ecodistricts in the Dry Mixedgrass Natural Subregion

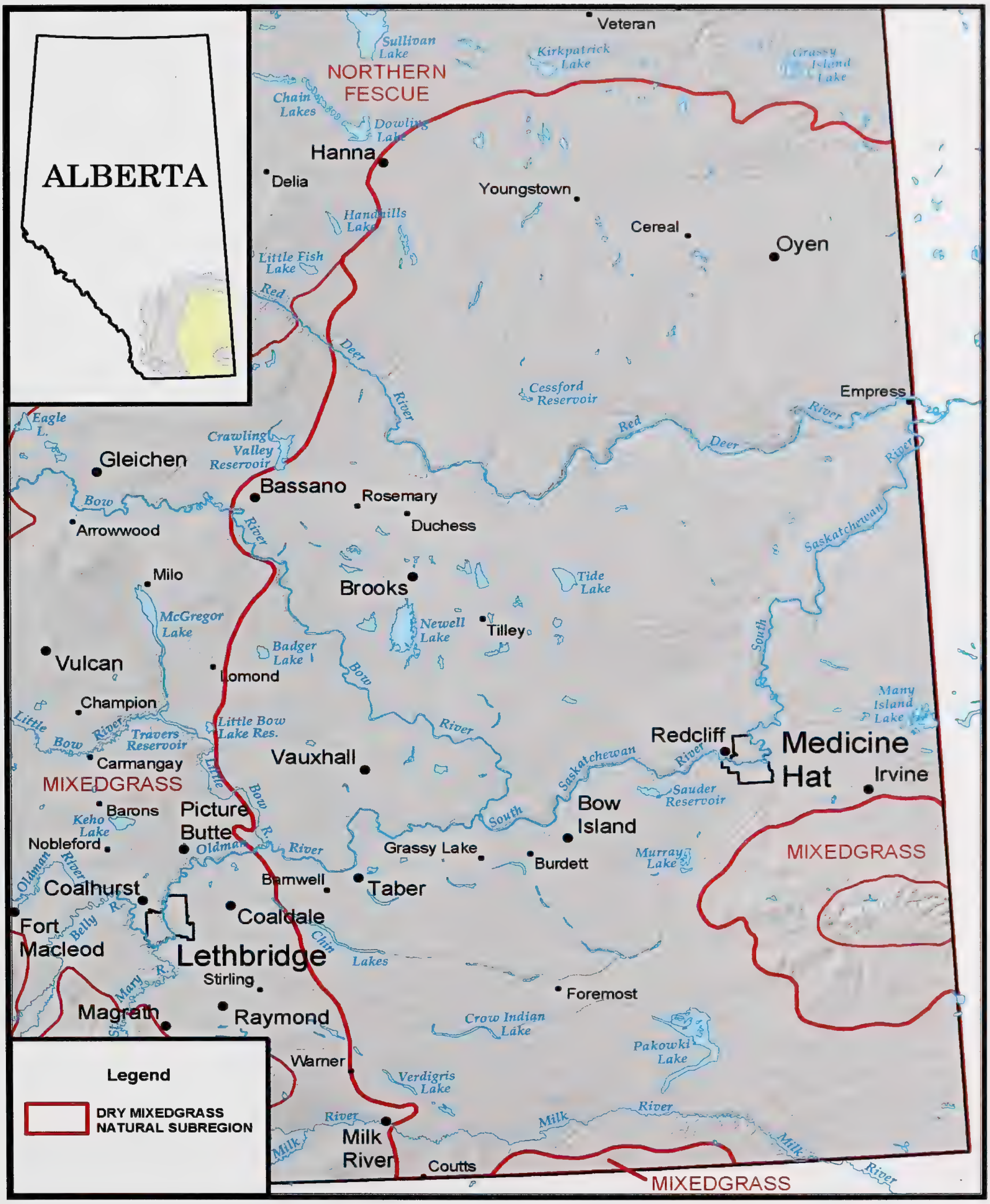

Figure 3: Dry Mixedgrass Natural Subregion with Hillshade Model (Digital Elevation Model)

2.1.2 Climate

The climate in the Dry Mixedgrass Natural Subregion is dry. Summers are short with warm to hot days and cool nights. Winters are long and cold. Climate data reported in Table 2 includes all data for all recorded stations in the Dry Mixedgrass Natural Subregion.

Table 2. Summary of climate data for stations in the Dry Mixedgrass Ecoregion, 1971 to 2000. Data provided by Environment Canada (2002).

Ecodistrict	**Station**	**Elevation (m)**	**°N; °W**	**Mean Daily Temp. (°C)**	**Total precip. (P) (mm)**	**Mean precip. as rain (%)**	**% of ppt. from May to Sept.**	**Effective Growing Degree Days (EGDD > 5°C)**
Wildhorse Plain	Altawan	945	49°14’; 110° 01’	2.5	329.2	69.3	61.9	1629
	Onefour	934	49° 07’; 110° 28’	4.7	353.0	65.8	59.0	1792
Foremost Plain	Foremost	892	49° 28’; 110° 26’	5.5	382.8	69.8	61.4	1807
	Maisinisin	953	49° 07’;110° 39’	6.1	407.2	67.0	58.7	
Purple Springs Plain	Taber	811	49° 47’; 112° 07’	5.8	368.4	70.8	60.6	1839
Bindloss Plain	Medicine Hat Airport	717	50° 01’; 110° 43’	5.7	333.8	74.8	65.5	1963
	Empress	613	50° 57’; 110° 00’	4.4	291.5	77.3	69.3	1903
Berry Creek Plain	Suffield Airport	770	50° 16’; 111° 11’	5.0	318.2	72.6	63.7	1870
	Big Stone	774	51° 10’; 111° 12’	3.8	337.4	77.6	71.2	-------
Brooks Plain	Brooks Hort. Centre	758	50° 33’; 111° 51’	4.2	348.0	74.8	64.2	1713
	Brooks N	759	50° 37’; 111° 53’	-------	354.2	72.9	62.4	-------
Oyen Plain	Oyen – Cappon	793	51° 10’; 110° 31’	3.8	321.5	78.3	72.3	1683
	Sibbald	725	51° 28’; 110° 15’	2.6	313.8	74.0	68.8	-------

Mean daily temperatures are lowest near the Saskatchewan border at Altawan (2.5°) and Sibbald (2.6°), and highest in the southwest (5.8° at Taber and 6.1° at Maisinisin) where winter temperatures are more moderated by Chinooks.

Total precipitation is lowest in the east, where it ranges from 291.5 to 321.5 mm at Empress, Suffield, Oyen-Cappon and Sibbald, and highest in the southwest, where it ranges from 368.4 to 407.2 mm at Taber, Foremost and Maisinisin.

Mean precipitation as rain is lowest in the south, where it ranges from 65.8 to 70.8% at Onefour, Maisinisin, Altawan, Foremost, and Taber, and highest in the northeast, where it ranges from 77.3 to 78.3% at Empress, Big Stone and Oyen-Cappon. The percentage of precipitation during the growing season is also lowest in the south (59 to 62%), and highest in the northeast (69 to 72%).

The station with the highest elevation, Altawan, has the shortest growing season. The Empress station is at the lowest elevation but the Medicine Hat station has the longest growing season due to the combination of low elevation and more southerly location. The relatively short growing season at Oyen-Cappon is related to the proximity to the Northern Fescue boundary.

The Dry Mixedgrass is characterized by the largest number of Effective Growing Degree Days and the lowest annual precipitation of the three Natural Subregions in southern Alberta (Table 3). Mean daily temperatures in the Mixedgrass Natural Subregion are higher than in the Dry Mixedgrass because it experiences more intense Chinooks. Chinooks are an intense dry westerly or southwesterly wind created by the orographic rise of westerly air masses over the Rocky Mountain divide.

Table 3. Climate indicators averaged over all recorded stations for the Dry Mixedgrass and bordering Natural Subregions.

Natural Subregion	Reference	Mean Daily Temperature (°C)	Mean Total Precipitation (mm)	Effective Growing Degree Days (>5°C)
Dry Mixedgrass, AB	Table 2 above	4.5	343	1800
Dry Mixedgrass, SK	SERM 1998	4.0	352	1797
Mixedgrass	Adams et al. 2004	5.0	419	1620
Northern Fescue	McNeil 2004	2.7	405	1460

2.1.3 Physiography and Soils

Physiography describes the physical nature of land, related to geology, elevation, aspect, slope, surface pattern, and drainage. Physiography in the Dry Mixedgrass Natural Subregion is mainly dominated by the Eastern-Alberta Plain (Pettapiece 1986), with a few bedrock-controlled upland areas (Fig. 3).

Surficial Geology

Most of southern Alberta is covered with glacial deposits resulting from the Continental glaciation, which receded from the area about 12,000 years ago. Glacial till is the dominant surficial deposit in the Dry Mixedgrass Natural Subregion. Glacial till is an unsorted mixture of sand, silt and clay mixed with coarse fragments, deposited directly from the ice. Glacial till tends to be thickest in ice-front positions, which can be vast. In general, two former ice-front positions are indicated by relatively thick glacial tills in the Dry Mixedgrass Natural Subregion: 1) the Cypress Slope, Foremost Plain, and to a lesser degree, the Vauxhall Plain; and 2) the Schuler Plain, Rainy Hills Upland and Oyen Plain. Thin glacial till over bedrock predominates in the Wildhorse, Bow City, Berry Creek, and Sounding Creek Plains.

Glaciolacustrine sediments are the second most common parent material in the Dry Mixedgrass. They consist of silt and clay settled from suspension in ice-marginal glacial lakes. The Brooks, Acadia Valley, and Sibbald Plains are dominated by glaciolacustrine basins.

Glaciofluvial (sometimes called outwash) sediments were deposited by fast-moving glacial meltwater. In the Dry Mixedgrass they often occur along the middle and upper terraces of major river and creek valleys. Glaciofluvial sediments are often composed of over 50% gravel and cobbles, within a coarse-textured matrix of loamy sand and sand that may occur in lenses or bands. Eolian sediments are composed of glaciofluvial material that has been selectively re-sorted by wind into sand dunes. Glaciofluvial and eolian materials are the predominant surficial sediments in the Purple Springs and Bindloss Plains. Eolian material specifically occurs in the Middle Sand Hills, Pakowki Sand Hills, Rolling Hills east, Grassy Lake – Grand Forks, and the Matzhiwin area.

Lower terraces and floodplains along rivers and creeks are dominated by recent fluvial deposits, which can consist of alternating layers of sand, silt and gravel.

Bedrock Geology

Most subcropping bedrock in the Dry Mixedgrass Natural Subregion was deposited in the upper Cretaceous, between about 80 and 65 million years ago. Bedrock is almost flat-lying, and dips gently to the west with dips rarely exceeding 40 m per km (Robertson and Hendry 1982).

The Bearpaw Shale Formation was deposited in an inland sea, and consists largely of soft, fissile and friable, dark gray shale. The Oldman and Foremost members of the Judith River formation were mainly deposited in non-marine alluvial environments, and consist of thin lenticular beds of fine-grained sandstone, siltstone, and thin layers of mudstone and shale. Coal seams are common in the Foremost, but occur only near the top of the Oldman (Robertson and Hendry 1982).

The Pakowki and Milk Formations subcrop in the Milk River valley. The Pakowki Formation is dominated by dark gray shale with minor beds of sandstone. The Milk River formation consists of massive, cross-bedded sandstone (Robertson and Hendry 1982). The Milk River sandstone is an important artesian aquifer in southeastern Alberta, that recharges in the Sweetgrass Hills in northern Montana (Hendry et al. 1991).

2.2 Correlation of Soils and Range Sites

The major soil series and their associated range sites for each ecodistrict in the Dry Mixedgrass Natural Subregion are summarized in Table 4. LandWise Inc. (1998, 2001, 2003) has developed soil correlation guidelines to link soils to range site types. A complete listing of range site types can be found in Appendix 9.1 in Table 14.

- **Soil correlation guidelines for range sites in SCA 1 are found in Table 5 in the following pages.** You can use AGRASID 3.0 or a published soil survey report to determine the dominant and subdominant soils for the site you wish to evaluate. Use the soil series name or three letter name abbreviation to determine range site.

- Range site can also be determined using the Range Site descriptions in section 2.3 on page 17 which includes a more comprehensive approach to determine range site by combining soil features (e.g. soil series), landscape characteristics and soil texture to determine range site.
- **See Appendix 9.2 A Concise Guide to Assist Users of AGRASID**

Soil Orders and Great Groups in the Dry Mixedgrass Natural Subregion:

Brown Chernozemic soils dominate in the Dry Mixedgrass Natural Subregion, as opposed to Dark Brown Chernozems in each of the Mixedgrass and Northern Fescue Natural Subregions (Table 1). Chernozemic soils are well- to imperfectly-drained soils that have developed under grassland communities. They are characterized by a dark-colored surface (A) horizon that is about 10 to 15 cm thick, resulting from the accumulation of debris from the accumulation and decomposition of organic matter derived from grasses and forbs. The A horizon of Brown Chernozems has a color value darker than 3.5 moist and 4.5 to 5.5 dry. Chroma is usually greater than 1.5. Free lime is generally leached to 30 cm or less. The soil climate is cold, rarely mild, and subarid to semiarid (SCWG 1998).

Solonetzic soils are the second most common soils in the Dry Mixedgrass (Fig. 4). They usually occur where sodium rich bedrock material occurs at or near the soil surface, but they can also occur in areas with former saline and sodic groundwater discharge. Solonetzic soils in the Dry Mixedgrass are mainly associated with the Bearpaw and Pakowki Shales, particularly where the overlying surficial materials are thin. Solonetzic soils are characterized by a subsoil hardpan layer (B horizon) that contains a high proportion of sodium, which causes it to be hard when dry, and impervious and very sticky when wet (Fig. 4).

Regosolic soils are the third most common soil in the Dry Mixedgrass. Regosols lack a B horizon, and may also be characterized by a shallow A horizon. Regosols are weakly developed soils for many reasons, which can include development on young geologic materials (floodplains, saline or sodic valley settings, or sand dunes), or in unstable locations, such as steep slopes, active floodplains, or locations prone to wind erosion. Fig. 5 portrays the sequence of soil development from saline and sodic Regosolic soils through Solonetzic to Chernozemic soils in a valley setting that formerly experienced a high water table due to groundwater discharge.

Gleysolic soils are of limited aerial extent in the Dry Mixedgrass. Gleysols are subject to periodic flooding or prolonged wetting, and typically lack oxygen during a portion, or most, of the growing season. Gleysols are often nutrient poor due to denitrification, and because decomposition is hindered by wetness. Gleysols are associated with wetlands enriched by either saline groundwater discharge or surface-water collection.

Vertisolic soils have a very limited occurrence in the Dry Mixedgrass, occurring mainly in the Acadia Valley area. Vertisols are characterized by a high clay content, with the result that they are subject to intense shrink-swell cycles.

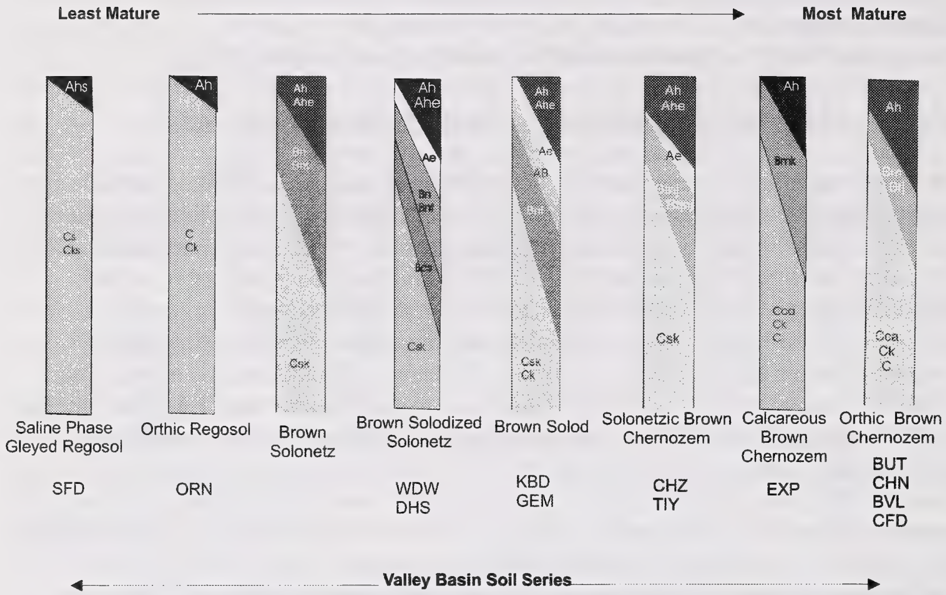

Fig. 4. An example of soil profile development and the applicable soil series related to a valley or basin setting in the Dry Mixedgrass Natural subregion. The soil series listed are examples that represent the various stages of solonetzic soil development is not inclusive of all relevant soil series.

Table 4. Major soils and associated ecological range sites, by Ecodistrict or area.

Ecodistrict or Sub-Ecodistrict	Major Soil Series	Soil Subgroup	Parent Material	Ecological/Range Site
Wildhorse Plain	SIL (Steveville)	Brown Solodized Solonetz	glacial till over softrock	Blowout (Blo)
	HUK (Hemaruka)	Brown Solodized Solonetz	glacial till	Blowouts (BlO)
	HDY (Halliday)	Brown Solod	glacial till	Blowouts (BlO) and Loamy (Lo)
	ROL (Ronalaine)	Solonetzic Brown Chernozem	glacial till	Loamy (Lo)
	MAB (Maleb)	Orthic Brown Chernozem	glacial till	Loamy (Lo)
	WDW (Wardlow)	Brown Solodized Solonetz	medium glaciolacustrine	Blowouts (BlO)
	BUT (Bunton)	Orthic Brown Chernozem	medium glaciofluvial	Overflow (Ov)
	PHN (Pinhorn)	Orthic Brown Chernozem	glacial till veneer over softrock	Loamy (Lo) and Thin Breaks (TB)
Foremost Plain	MAB (Maleb)	Orthic Brown Chernozem	glacial till	Loamy (Lo)
	CFD (Cranford)	Orthic Brown Chernozem	medium glaciolacustrine over glacial till	Loamy (Lo)
	MSN (Masinasin)	Orthic Brown Chernozem	glacial till	Loamy (Lo)
	CLR (Clarinda)	Rego Brown Chernozem	glacial till	Limy (Li)
	TVS (Travers)	Calcareous Brown Chernozem	glacial till	Limy (Li)
	CHN (Chin)	Orthic Brown Chernozem	medium glaciolacustrine	Loamy (Lo)
Purple Springs Plain	BVL (Bingville)	Orthic Brown Chernozem	moderately coarse fluvial	Sandy (Sy)
	CVD (Cavendish)	Orthic Brown Chernozem	coarse fluvial	Sands (Sa)
	ANO (Antonio)	Orthic Brown Chernozem	moderately coarse fluvial veneer over glacial till	Sandy (Sy)
	PLS (Purple Springs)	Orthic Brown Chernozem	coarse fluvial veneer over glacial till	Sands (Sa)
	CFD (Cranford)	Orthic Brown Chernozem	medium glaciolacustrine over glacial till	Loamy (Lo)
	VST (Vendisant)	Rego Brown Chernozem	coarse fluvial - eolian	Sands (Sa) and Choppy Sandhills (CS)
Vauxhall Plain	MAB (Maleb)	Orthic Brown Chernozem	glacial till	Loamy (Lo)
	CFD (Cranford)	Orthic Brown Chernozem	medium glaciolacustrine over glacial till	Loamy (Lo)
	CHN (Chin)	Orthic Brown Chernozem	medium glaciolacustrine	Loamy (Lo)
	BVL (Bingville)	Orthic Brown Chernozem	moderately coarse fluvial	Sandy (Sy)
	HDY (Halliday)	Brown Solod	glacial till	Blowouts (BlO) and Loamy (Lo)
Bow City Plain	HDY (Halliday)	Brown Solod	glacial till	Blowouts (BlO) and Loamy (Lo)
	HUK (Hemaruka)	Brown Solodized Solonetz	glacial till	Blowouts (BlO)
	ROL (Ronalaine)	Solonetzic Brown Chernozem	glacial till	Loamy (Lo)
	MAB (Maleb)	Orthic Brown Chernozem	glacial till	Loamy (Lo)
Brooks Plain	TIY (Tilley)	Solonetzic Brown Chernozem	medium glaciolacustrine	Loamy (Lo)
	CHN (Chin)	Orthic Brown Chernozem	medium glaciolacustrine	Loamy (Lo)
	CVD (Cavendish)	Orthic Brown Chernozem	coarse fluvial	Sands (Sa)
	BVL (Bingville)	Orthic Brown Chernozem	moderately coarse fluvial	Sandy (Sy)
	RIR (Rainier)	Orthic Brown Chernozem	moderately coarse	Sandy (Sy)

Ecodistrict or Sub-Ecodistrict	Major Soil Series	Soil Subgroup	Parent Material	Ecological/Range Site
			glaciofluvial veneer over medium glaciolacustrine	
	WDW (Wardlow)	Brown Solodized Solonetz	medium glaciolacustrine	Blowouts (BlO)
	KBD (Karlsbad)	Brown Solod	medium glaciolacustrine	Loamy (Lo) and Blowouts (BlO)
	RMR (Rosemary)	Brown Solod	fine glaciolacustrine	Blowouts (BlO) and Clayey (Cy)
	MCT (Millicent)	Solonetzic Brown Chernozem	fine glaciolacustrine	Clayey (Cy)
	ANO (Antonio)	Orthic Brown Chernozem	moderately coarse fluvial veneer over glacial till	Sandy (Sy)
Berry Creek Plain	HDY (Halliday)	Brown Solod	glacial till	Blowouts (BlO) and Loamy (Lo)
	HUK (Hemaruka)	Brown Solodized Solonetz	glacial till	Blowouts (BlO)
	ROL (Ronalaine)	Solonetzic Brown Chernozem	glacial till	Loamy (Lo)
	SIL (Steveville)	Brown Solodized Solonetz	glacial till over softrock	Blowouts (BlO)
	KTM (Kitsim)	Saline Rego Gleysol	glacial till	Saline Lowland (SL)
Sounding Creek Plain	HUK (Hemaruka)	Brown Solodized Solonetz	glacial till	Blowouts (BlO)
	YTW (Youngstown)	Brown Solodized Solonetz	moderately coarse glaciofluvial	Blowouts (BlO)
	YNY (Yarnley)	Brown Solodized Solonetz	very coarse fluvial - eolian	Blowouts (BlO) and Sands (Sa)
	GPH (Gopher)	Brown Solodized Solonetz	moderately coarse glaciofluvial veneer over glacial till	Blowouts (BlO) and Sandy (Sy)
	CVD (Cavendish)	Orthic Brown Chernozem	coarse fluvial	Sands (Sa)
	BVL (Bingville)	Orthic Brown Chernozem	moderately coarse fluvial	Sandy (Sy)
	VST (Vendisant)	Rego Brown Chernozem	coarse fluvial - eolian	Sands (Sa) and Choppy Sandhills (CS)
	SIL (Steveville)	Brown Solodized Solonetz	glacial till over softrock	Blowouts (BlO)
	DHP (Dishpan)	Saline Rego Gleysol	medium glaciolacustrine	Saline Lowland (SL)
	MAB (Maleb)	Orthic Brown Chernozem	glacial till	Loamy (Lo)
	ROL (Ronalaine)	Solonetzic Brown Chernozem	glacial till	Loamy (Lo)
Sibbald Plain	CHN (Chin)	Orthic Brown Chernozem	medium glaciolacustrine	Loamy (Lo)
	TIY (Tilley)	Solonetzic Brown Chernozem	medium glaciolacustrine	Loamy (Lo)
	FMT (Foremost)	Orthic Brown Chernozem	glacial till	Loamy (Lo)
	KBD (Karlsbad)	Brown Solod	medium glaciolacustrine	Loamy (Lo) and Blowouts (BlO)
	SPS (Seven Persons)	Orthic Brown Chernozem	fine glaciolacustrine	Clayey (Cy)
	BVL (Bingville)	Orthic Brown Chernozem	moderately coarse fluvial	Sandy (Sy)
	ACV (Acadia Valley)	Calcareous Brown Chernozem	fine glaciolacustrine	Limy (Li) and Clayey (Cy)
Oyen Plain	MAB (Maleb)	Orthic Brown Chernozem	glacial till	Loamy (Lo)
	TVS (Travers)	Calcareous Brown Chernozem	glacial till	Limy (Li)
	HMS (Helmsdale)	Rego Brown Chernozem	glacial till	Limy (Li)
	CFD (Cranford)	Orthic Brown Chernozem	medium glaciolacustrine	Loamy (Lo)

Ecodistrict or Sub-Ecodistrict	Major Soil Series	Soil Subgroup	Parent Material	Ecological/Range Site
			over glacial till	
	ROL (Ronalaine)	Solonetzic Brown Chernozem	glacial till	Loamy (Lo)
	BVL (Bingville)	Orthic Brown Chernozem	moderately coarse fluvial	Sandy (Sy)
Acadia Valley Plain	ACV (Acadia Valley)	Calcareous Vertic Brown Chernozem	fine glaciolacustrine	Limy (Li) and Clayey (Cy)
	WDN (Wheiden)	Vertic Brown Chernozem	fine lacustro-till	Clayey (Cy)
	SPS (Seven Persons)	Orthic Brown Chernozem	fine glaciolacustrine	Clayey (Cy)
	TVS (Travers)	Calcareous Brown Chernozem	glacial till	Limy (Li)
Bindloss Plain	BVL (Bingville)	Orthic Brown Chernozem	moderately coarse fluvial	Sandy (Sy)
	CVD (Cavendish)	Orthic Brown Chernozem	coarse fluvial	Sands (Sa)
	PLS (Purple Springs)	Orthic Brown Chernozem	coarse fluvial veneer over glacial till	Sands (Sa)
	VST (Vendisant)	Rego Brown Chernozem	coarse fluvial - eolian	Sands (Sa) and Choppy Sandhills (CS)
	ATP (Antelope)	Orthic Regosol	very coarse eolian	Choppy Sandhills (CS)
	CHN (Chin)	Orthic Brown Chernozem	medium glaciolacustrine	Loamy (Lo)
Rainy Hills Upland	FMT (Foremost)	Orthic Brown Chernozem	glacial till	Loamy (Lo)
	MAB (Maleb)	Orthic Brown Chernozem	glacial till	Loamy (Lo)
	ROL (Ronalaine)	Solonetzic Brown Chernozem	glacial till	Loamy (Lo)
	TVS (Travers)	Calcareous Brown Chernozem	glacial till	Limy (Li)
	KGO (Kangaroo)	Orthic Brown Chernozem	gravelly very coarse glaciofluvial	Sands (Sa) and Gravel (Gr)
	CFD (Cranford)	Orthic Brown Chernozem	medium glaciolacustrine over glacial till	Loamy (Lo)
	HDY (Halliday)	Brown Solod	glacial till	Blowouts (BlO) and Loamy (Lo)
Schuler Plain	CFD (Cranford)	Orthic Brown Chernozem	medium glaciolacustrine over glacial till	Loamy (Lo)
	FMT (Foremost)	Orthic Brown Chernozem	glacial till	Loamy (Lo)
	CHN (Chin)	Orthic Brown Chernozem	medium glaciolacustrine	Loamy (Lo)
	BVL (Bingville)	Orthic Brown Chernozem	moderately coarse fluvial	Sandy (Sy)
	LLB (Lilybrown)	Saline Brown Chernozem	medium glaciolacustrine	Saline Lowland (SL)
	BUT (Bunton)	Orthic Brown Chernozem	medium glaciofluvial	Overflow (Ov)
Cypress Slope	MAB (Maleb)	Orthic Brown Chernozem	glacial till	Loamy (Lo)
	CFD (Cranford)	Orthic Brown Chernozem	medium glaciolacustrine over glacial till	Loamy (Lo)
	HDY (Halliday)	Brown Solod	glacial till	Blowouts (BlO) and Loamy (Lo)
	ROL (Ronalaine)	Solonetzic Brown Chernozem	glacial till	Loamy (Lo)

Table 5. SCA 1 Brown Soil Zone - Dry Mixedgrass Natural Subregion
Soil series of Soil Correlation Area 1 linked to Ecological Range Sites

Productiv-ity Rating	**Ecological/Range Site**	**Soil or Landscape Description**	**Soil Series**
More herbage due to superior soil moisture	Overflow (Ov)	Fan, apron, channeled or concave (non-saline) landscapes	**BUT, MCN, MKR, ORN**
	Subirrigated (Sb)	Gleyed; imperfectly drained (CSSC 1998)	MHN
	Wetlands (WL)	Gleysols; poorly drained (CSSC 1998)	INS, IWT, KTM, NDP, SKF, SLY, TEP, WLH, ZGW
Normal vegetation response	Clayey (Cy)	Fine (FI) or very fine (VF) textures (see Fig. 5)	**ACV**, MCT, RMR, SPS, WDN
	Loamy (Lo)	Medium (ME) or moderately fine (MF) textures (see Fig. 5)	**BUT**, CCL, CFD, CHN, CHZ, EXP, FMT, MAB, **MCN**, MSN, **PHN**, ROL, TIK, TIY, **VGR**
	Sandy (Sy)	Moderately coarse (MC); or very coarse (VC) veneer over medium (ME) textures	ANO, BVL, **CMY, GPH, KGO, MKR**, PLS, **RHS**, RIR, **RRD**, **SYK**, TAB, **VGR, YTW**
Limited by moisture (or soluble salts adversely affecting plant growth)	Badlands (BdL)	Bedrock exposures >10%, and bedrock generally <1m deep; AGRASID landscape models include I4, I4m, and I5	ZCV, **ZUN**
	Blowouts (BlO)	Dominant or co-dominant soils in the Solonetzic order (CSSC 1998)	BLP, DHS, GEM, **GPH**, HDY, HUK, KBD, PTA, **RHS**, RMR, **RRD**, SIG, **SIL**, **SYK**, WDW, **YNY**, **YTW**, ZSZ
	Choppy Sandhills (CS)	Duned landscape models; very coarse (VC) textures (see Fig. 5)	ATP, **VST**
	Gravel (Gr)	Gravels at the surface or <30 cm from the surface	EZM, KGO, PUN
	Limy (Li)	Calcareous or Rego subgroups; or eroded phases (CSSC 1998)	**ACV**, CLR, **EXP**, HMS, **MCN**, **MKR**, **ORN**, **TVS**, **VGR**, ZER
	Saline Lowlands (SL)	Saline discharge; salt-enriched	DHP, GLS, KTM, LYB, **MCN**, SFD, ZNA
	Sands (Sa)	Very coarse (VC) and not duned (CSSC 1998)	CVD, **VST**, **YNY**
	Shallow to Gravel (SwG)	veneer (30 – 100 cm) over gravels	RAM
	Thin Breaks (TB)	Bedrock generally, 1 - 5 m; bedrock exposures <10%	**CMY, PHN, SIL, ZUN**

2.3 Procedure for Determining Range Sites in the Dry Mixedgrass Natural Subregion

The following key provides a simplified procedure for linking Ecological/Range sites to soil and landscape information. Range sites are divided into three groups based on their main defining feature of landscape, soil feature or soil texture. **Table 5 provides a summary of the following correlation of range sites with soil series, soil textures and other soil features. Also refer to Table 20 in Appendix 9.2 to find full soil series names.**

Group 1 - Range Sites Defined Mainly by Landscape

Badlands/Bedrock (BdL):

Applies to all inclined to steeply sloping landscapes with greater than 10% bedrock exposures of softrock or hardrock. Slopes generally range from 15% to 60% (in isolated cases 7% to 100%). Includes I4m, I4h and I5 landscape models from AGRASID 3.0.

Overflow (Ov):

Applies to non-saline Chernozemic (soils with A, B and C horizons) and/or Regosolic soils (soils that lack a B horizon >5 cm thick, and may lack an A horizon) on landscapes that are low-relief inclines in valley or basinal settings. Overflow sites are usually fan or apron deposits, where upslope streams enter lowland areas and experience a marked decrease in gradient. Slopes generally range from 2% to 9% (in isolated cases from 0.5% to 15%). Overflow occurs only on lower slope positions or adjacent to stream(s), and the percentage of eligible overflow ranges from 10% to 50% per SLM (specific rules within each SCA). Ov includes I3l and I4l landscape models from AGRASID 3.0, and also applies to the soil series Bunton (BUT).

Riparian (Ri):

Applies to all stream channels and floodplains. Includes FP1, FP2, FP3, SC1-l, SC1-h, SC2, SC3 and SC4 landscape models from AGRASID 3.0. True riparian areas only include the valley floor (from bottom of bank to bottom of bank on the other side of the valley).

Thin Breaks (TB):

Applies to: 1) all steeply-sloping landscapes with less than 10% bedrock exposures; 2) largely vegetated areas with bedrock at or near (within 5 m of) the surface; 3) the soil series Comry (CMY) and Pinhorn (PHN), and 4) AGRASID 3.0 landscape models I3m, I3h or I4m.

Group 2 - Range Sites Defined Mainly by Soil Features

Blowouts (BlO):

Applies to all SLMs where soils from the Solonetzic order are dominant (>50%) or co-dominant (30 to 50%). Solonetzic soils have an impervious hardpan layer (Bnt horizon) in the subsoil that is caused by excess sodium (Na+). The land surface is frequently characterized by eroded pits. Applies to the soil series Bullpound (BLP), Duchess (DHS), Gem (GEM), Gopher (GPH), Halliday (HDY), Hemaruka (HUK), Karlsbad (KBD), Patricia (PTA), Rolling Hills (RHS), Rosemary (RMR), Rolward (RRD), Stirling (SIG), Steveville (SIL), Sunnynook (SYK), Wardlow (WDW), Yarnley (YNY), Youngstown (YTW), and also applies to undifferentiated Solonetz (ZSZ).

Limy (Li):

Applies to all immature or eroded soils with free lime (calcium carbonates) at the soil surface or in the B horizon. Free lime is detected by effervescence when soil is treated with 10% hydrochloric acid (HCl). Li soils include Rego or Calcareous Chernozemics, eroded phases, and subgroups from the Regosolic order if they are calcareous. Applies to the soil series Acadia Valley (ACV), Clarinda (CLR), Expanse (EXP), Helmsdale (HMS), Milk River (MKR), Orion (ORN), Travers (TVS), Verdigris (VGR), and Undifferentiated Eroded (ZER) if not on I3l, I3h, I4m or I4h landscapes.

Sub-irrigated (Sb):

Applies to all Gleyed, non-saline, medium to very coarse textured soils. Applies to the soil series Meachin (MHN). Gleyed soils occur where the water table occurs near the soil surface, but does not often occur above the soil surface. Gleyed subgroups have faint to distinct mottles within 50 cm, or prominent mottles between 50 and 100 cm.

Saline Lowland (SL):

Applies to all salt-enriched soils, including Saline phase Chernozemic, Saline phase Regosolic, and Saline phase Gleysolic soils. Saline phase soils have an electrical conductivity greater than 4.0 dS/m, which retards most plant growth. Applies to the soil series Dishpan (DHP), Gleddies (GLS), Kitsim (KTM), Lilybrown (LYB), McNab (MCN), and Scotfield (SFD), and also applies to undifferentiated saline soils (ZNA).

Wetlands (WL):

Applies to all non-saline or weakly-saline of the Gleysolic and Organic orders. Gleysolic soils occur in seasonal to semi-permanent wetlands. They are typified by dull colours or prominent mottles with 50 cm, due to prolonged periods of intermittent or continuous saturation, and the lack of oxygen in the soil. Organic soils are dominated by the accumulation of decomposing peat material derived mainly from sedges and reeds. Applies to the Gleysolic soil series Islands (INS), Illingworth (IWT), Niedpath (NDP), Skiff (SKF), Sloughay (SLY), Tempest (TEP), and Walsh (WLH), and also applies to undifferentiated wet soils (ZGW).

Group 3 - Range Sites Defined Mainly by Textural Groupings

Soils are made up of varying components of sand, silt and clay, with the sum of the three equal to 100% (Fig. 5). Soils may also include particles larger than 2.0 mm, or coarse fragments (Table 6).

Table 6. Definition of soil particle sizes.

Category	Particle	Diameter (mm)
Components of soil texture	clay	<0.002
	silt	0.002 to 0.05
	sand	0.05 to 2
Coarse fragments	gravel	2 to 75
	cobbles	75 to 250
	stones	250 to 600
	boulders	>600

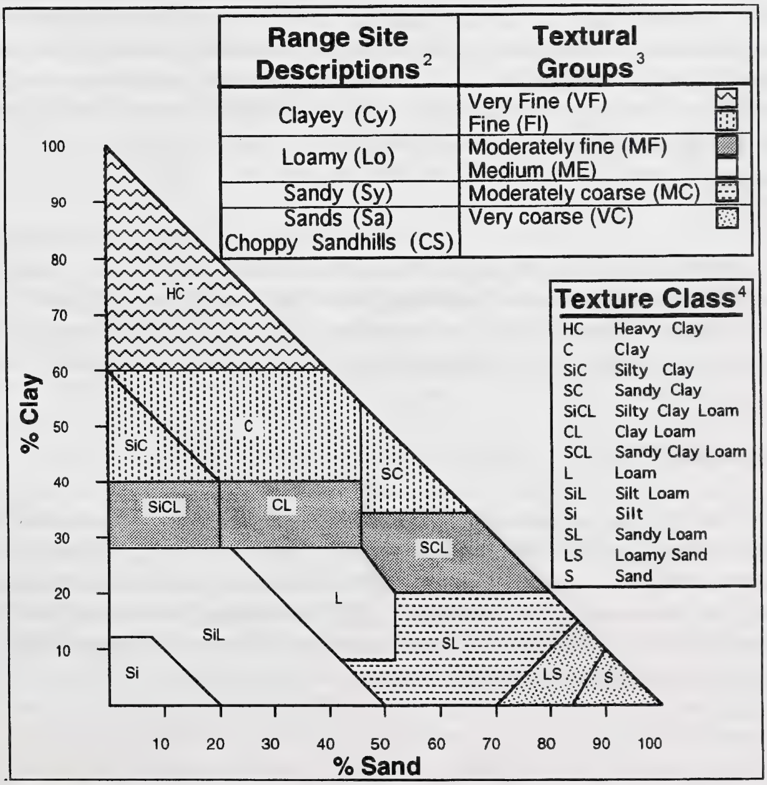

Fig. 5 Soil textures and their relationship to ecological range sites.

Clayey (Cy):

Applies to all non-saline and non-gleyed Chernozemic soils (soils with A, B and C horizons), and non-saline and non-gleyed Regosolic soils (soils that lack a B horizon >5 cm, and may lack an A horizon) with soil textures in the fine or very fine (E.g., clay and silty clay) textural subgroups (>40% clay, Fig. 6). Applies to the soil series Millicent (MCT), Seven Persons (SPS) and Wheiden (WDN).

Loamy (Lo):

Applies to all non-saline and non-gleyed Chernozemic soils (soils with A, B and C horizons), and non-saline and non-gleyed Regosolic soils (soils that lack a B horizon >5 cm, and may lack an A horizon) with soil textures in the medium and moderately fine textural subgroups (E.g., loam and clay loam, Fig. 6). Applies to the soil series Cecil (CCL), Cranford (CFD), Chin (CHN), Chinz (CHZ), Foremost (FMT), Maleb (MAB), Maisinisin (MSN), Ronalaine (ROL), Timko (TIK) and Tilley (TIY).

Sandy (Sy):

Applies to all non-saline and non-gleyed Chernozemic soils (soils with A, B and C horizons), and non-saline and non-gleyed Regosolic soils (soils that lack a B horizon >5 cm, and may lack an A horizon) with soil textures in the moderately coarse (sandy loam) textural subgroup. Applies to the soil series Antonio (ANO), Bingville (BVL), Purple Springs (PLS), Rainier (RIR), and Taber (TAB).

Sands (Sa):

Applies to all non-saline and non-gleyed Chernozemic soils (soils with A, B and C horizons), and non-saline and non-gleyed Regosolic soils (soils that lack a B horizon >5 cm, and may lack an A horizon) with soil textures in the very coarse (loamy sand) textural subgroup. Sa does not apply to duned landscapes. Applies to the soil series Cavendish (CVD).

Choppy Sandhills (CS):

Applies to all non-saline and non-gleyed Chernozemic soils (soils with A, B and C horizons), and non-saline and non-gleyed Regosolic soils (soils that lack a B horizon >5 cm, and may lack an A horizon) with soil textures in the very coarse (loamy sand) textural subgroup. CS applies to soils that occur on duned landscapes, including D1l, D1m, D1h, D2l, D2m and D2h in AGRASID 3.0. Applies to the soil series Antelope (ATP) and Vendisant (VST), but only on duned landscapes.

Gravel (Gr):

Applies to any soil with less than 20 cm of a surface mantle of any textural class over very gravelly or very cobbly (>50% gravel or cobbles) material. Applies to the Etzikom

(EZM), Kangaroo (KGO) and Pemukan (PUN) soil series.

Shallow to Gravel (SwG):

Applies to any soil with 20 to 50 cm of a surface mantle of any textural class overlying gravelly or very gravelly or cobbley to very cobbly (>20% gravel or cobbles) material. Applies to the Ramillies (RAM) soil series.

3..0 Review of Grazing Research in the Dry Mixedgrass Natural Subregion

Why is plant community important?

Ranchers and range resource managers generally strive to maintain plant communities at or near the climax or potential natural community(PNC) stage because this stage provides higher levels of ecological functioning. Healthy range plant communities are said to perform important ecological functions and to provide a broader suite of goods and services than lower seral stages. A rich history of grazing research has taken place in the Dry-Mixedgrass prairie at Agriculture and Agri-Food Canada research substation, at Onefour, where range management research was initiated in 1927. The Dominion Experimental Farms Service established the first rangeland research program in Canada at Onefour, near Manyberries Alberta. The research program provided the first scientifically based guidelines on stocking rates and range management practices in the country. Range management research has been continuous at the site and is ongoing. Although Onefour is located in the brown soil zone, much of the research has relevance to grazing management consideration in the dark brown soil zone of the Dry Mixedgrass Natural Subregion.

Ecological Status of the Dry Mixedgrass Prairie

Prior to the 1980's, the brown soil zone in Alberta was first described as “short grass” prairie, implying an ecological link to the short grass steppe of interior plains and a dominance of warm season species like Blue grama grass. Heavy grazing during the early decades of the 1900’s established a broad landscape level of impact on grassland plant communities that was recognized by early plant ecologists. When Coupland (1961, 1973) reflected on the works of Clark et al. (1942) and Hubbard (1950), and then on his own initial plant community studies (Coupland 1950), he concluded that the use of the term “short-grass” prairie was a misnomer. He observed that early studies that defined plant communities dominated by blue grama grass, were carried out after a period of poor moisture conditions and the abundance of Needle-and-Thread grass had been reduced by grazing pressure, much more so than early investigations had recognized. In other words, the earlier investigators observed a desertified range landscape by the time of the dustbowl and Great Depression. Since that time, mid-grasses like needle-and-thread grass, western porcupine grass, northern and western wheatgrass have become far more abundant on the landscape, establishing dominance on almost all range sites over the decumbent, low-growing, grazing-resistant blue grama. Today the brown soil zone is more appropriately described as the mixed grass prairie, implying the important presence of mid-grasses. For further discussion of the grazing history of the prairie region since European settlement, see Adams et al. 2004.

Since that time, with improved policy, range management knowledge and practices and climatic conditions, the Mixedgrass character of the brown and dark brown soil zones has been re-established as mid-grasses like needle-and-thread, Porcupine grass, Northern and Western wheatgrass have become far more abundant on the landscape, establishing dominance on almost all range sites over the decumbent, low-growing, grazing-resistant Blue grama.

Long-Term Stocking Rates Study

At Onefour, in the Dry Mixedgrass Natural Subregion, a nineteen-year study (Smoliak et al. 1972) compared three rates of stocking with sheep: **light,** 6.2 ac/AUM; **moderate**, 5.0 ac/AUM; and **heavy**, 4.2 ac/AUM. As grazing pressure increased, the deep-rooted grasses, such as needle-and-thread and Northern and Western wheatgrass, were replaced by shallow rooted and grazing resistant species like blue grama, low sedge and little club moss. Soil responses with increased stocking included a decline in deep-rooting plants (45 to 60 cm depth) and an increase in shallow-rooting plants (0 to 15 cm depth) and lower values for total carbon and its various components. Previous work (Clark et al. 1947) detected a significant decline in range condition on the mixed prairie, with as little as five years of heavy grazing.

A paradox exists between the fescue and mixedgrass prairies in terms of the impact of prolonged heavy grazing. While many similar changes occur in terms of plant species shifts from tall deep-rooted species to low, shallow-rooted species, the degree of impact to soil is different. While the black soils of the foothills fescue are seriously degraded under very heavy grazing most loamy mixedgrass soils remain relatively stable. An increased cover of blue grama grass and little club moss may help protect the soil surface from accelerated erosion and loss of valuable topsoil. There are no long-term studies that document soil and vegetation responses on choppy sandhill or blowout range sites in the mixedgrass prairie, where site/soil instability would likely be greater with heavy grazing pressure.

Grazing Impacts on Soils and Watershed Function

Heavy grazing can change the plant/soil micro-environment of the mixedgrass prairie as plant biomass is depleted from the soil surface (Whitman 1974). Changes include increased surface and subsoil temperatures and increased wind speeds at the soil surface, producing more severe evaporative conditions. At Onefour, removal of standing dead plant material over three successive years reduced forage yields to 40% of the control (Willms et al. 1986). Litter residue (mulch) is particularly vital in the mixedgrass prairie to reduce soil temperatures and to conserve scarce moisture. Early studies at Onefour recognized that either spring or fall burning reduced the herbage yield on mixedgrass prairie for a period of 3 to 5 years (Clark et al. 1943).

The principle range management strategy for improving water-use efficiency in this semiarid environment (Willms and Jefferson 1993) has two elements, first to promote plant species that are deep rooted and complete their growth before the summer drought and second, to manage grazing intensity to allow for the maintenance of adequate litter levels to enhance the utilization of scarce moisture.

Grazing Versus Protection

A recent study in Grassland National Park showed that protection from grazing for 7 to 17 years produced only modest impacts to structure and composition of mixedgrass prairie vegetation (Thorpe and Godwin 2003). On alluvial flats dominated by silver sagebrush, protected sites had higher vertical cover of grasses and shrubs. However, forb richness was significantly lower in ungrazed areas, a vegetation component of value to wildlife species like Sage-Grouse and Pronghorn.

It appears the impacts of grazing versus protection may differ by soil type. At Onefour, after seventy years of protection, ungrazed loamy range sites showed a higher proportion of Northern and Western wheatgrass and higher forage productivity (Willms et al. 2002). In the same study, the effect of long-term rest was neutral on blowout range sites where vegetation canopy cover is lower and the potential for litter accumulation is limited by solonetzic soil conditions. Plant community characteristics and productivity were similar between grazed and protected areas.

Blue grama grass is able to withstand heavy grazing pressure because it's short stature allows it to avoid grazing impact and it is better able to compete in dry environments (Weaver and Albertson 1956). Dormaar and Willms (1990) noted that previously heavily grazed mixedgrass prairie was still dominated by blue grama after 19 years of rest. However, in the Onefour study (Willms et al. 2002), overall range condition improved over a 70 year time frame. After 70 years, the cover of blue grama grass declined from about 55% in 1929 as determined by basal area (Clarke et al.1947) to about 8 and 21% as determined by canopy cover on protected and grazed treatments, respectively. The high proportion of blue grama in 1929 was thought to be indicative of previous heavy grazing and drought as described earlier.

Recovery of Dry Mixedgrass Prairie Following Cultivation and Abandonment

Several million acres of mixedgrass prairie were cultivated and abandoned in Alberta in the early decades of the 20th century (D. Major, Personal Comm., Special Areas Board, Hanna, AB). Coupland (1961) observed that the rate of plant community succession back to native mixedgrass prairie cover would depend on the size of the cultivated area, the distance to the supply of native seed stock, the degree of aridity of the years following abandonment and the length of time that tillage took place prior to abandonment. Succession back to a community dominated by mid-grasses, tended to be first through native and introduced annual forbs, then to native perennial forbs and finally perrenial grasses. Western wheatgrass was one of the first of the mid-grasses to reestablish. Under the most favorable of conditions, a late-seral community might develop within 20 years.

Recovery studies of abandoned cultivation (AC) near Lethbridge support this view. A pasture with dark brown chernozemic soils, that had been cultivated in the autumn of 1928 and abandoned by the spring of 1932, reverted to a needle-and-thread community. An exclosure built in 1978, spanning the AC and the original prairie unbroken prairie, showed a differential path to recovery. By 1992, the AC had a canopy cover dominated by needle-and-thread (79%) and fringed sage (6%), while on the uncultivated side of the exclosure, the uncultivated community was dominated by blue grama (51%) and needle-and-thread (18%). Again, blue grama grass has a competitive advantage with heavy grazing pressure (Smoliak 1974). Even with 14 years of rest, dominance of blue grama persisted. Cultivation and abandonment allowed needle-and-thread to regain dominance while blue grama persisted on the unbroken land.

Recovery of soil quality on AC takes much longer than vegetation. Dormaar et al.(1990) evaluated a number of soil quality factors on sites previously cultivated and abandoned in 1925, 1927, 1950 and 1975 and then grazed during the recovery process at moderate, and they predicted that it would take at least 70 years to restore the quality of soil organic matter found in native mixedgrass prairie soils.

Functions and Characteristics of Healthy Dry Mixedgrass Prairie Plant Communities

Table 7 provides a summary of the functions and values associated with healthy Dry Mixedgrass Prairie plant communities and background rational to why it is important to manage for a high standard of rangeland health.

Table 7. Functions and characteristics of healthy Dry Mixedgrass plant communities.

Functions and Characteristics of Dry Mixedgrass Communities	**Why are healthy plant communities important? Impact of excessive disturbance on values and functions.**
Forage Productivity	• forage production is highest from late-seral to climax plant communities • forage yield potential declines with loss of mid-grasses like needle-and-thread, western porcupine grass, northern and western wheatgrass
Production Stability and Risk	• forage yields are more stable at late-seral to climax stages with adequate litter residue to cool the soil and make scarce moisture more effective. • as species shift to lower seral communities, forage yields fluctuate more and are more dependent on current precipitation conditions
Managerial Efficiency and Flexibility	• Most late-seral native grasses have higher curability than early seral species (e.g. June grass, Sandberg bluegrass) and provide better late season grazing,, reducing wintering costs and making grazing options more flexible for the producer • Lower successional communities are subject to greater forage weathering losses and declines in forage quality and are unsuitable for winter grazing
Site Stability and Soil Maintenance	• Dry Mixedgrass plant communities vary in their normal site stability, but most normally have little exposed soil and are stable; as soil exposure exceeds about 10 to 15%, soil loss increases

Functions and Characteristics of Dry Mixedgrass Communities	**Why are healthy plant communities important? Impact of excessive disturbance on values and functions.**
Moisture Retention and Watershed Function	• Many Dry Mixedgrass plant communities produce substantial litter that serves to conserve scarce moisture, enhance moisture infiltration and retention • Adequate litter residue is critical to moisture conservation and to make scarce moisture more effective. Half the normal forage yield in an average year can be attributed to having adequate litter residue. Litter depletion from heavy grazing may impose a "man caused" drought.
Plant Community Structure	• Dry Mixedgrass plant communities should normally have a high proportion of mid-grasses and provide a taller plant community structure than observed in the Dry-Mixedgrass prairie. • plant community structure declines towards lower seral communities
Wildlife Habitat Values	• Grazing management can be manipulated to alter the structural characteristics of Dry Mixedgrass prairie by influencing the patch or structural diversity.
Biodiversity Maintenance	• highest species richness at light to moderate levels of grazing • ungrazed Dry Mixedgrass plant communities have simpler species composition with litter build up • heavy to very heavy grazing leads to species impoverishment • invasion by agronomic species leads to serious decline in plant species diversity

4.0 Previous Plant Community Studies

4.1 Native Plant Communities

Much of our understanding of the Mixedgrass prairie has been provided by Coupland (1950, 1961 and 1973).Coupland (1961) described the *Stipa-Agropyron* community type as one of the most common in the Mixedgrass Prairie, being very common on medium textured soils of the dark brown soil zone as well as the more productive upland sites of the brown soil zone. Though this community remains in relatively small parcels today, it was once of the most extensive Mixedgrass Prairie community prior to European settlement, but has been largely converted to cropland (Coupland 1973). With increased precipitation levels and cooler summer growing conditions, mid-grasses are more common. This grassland type was common to modal upland sites in the Mixedgrass and is found on moist loamy range sites in the Dry Mixedgrass in areas adjoining the Mixedgrass subregion and on a local scale on lower and north facing slopes. This community has the tallest graminoid structure of any of the grassland communities in the Dry Mixedgrass, with four mid-grasses including needle-and-thread, western porcupine grass, western wheatgrass, northern wheatgrass and green needle grass. Combined, these species provide over 65% of the forage yield (Coupland 1973). Blue grama grass is part of this community but normally occurs at 1 or 2 % cover. Where abundant, it is an indicator of past heavy grazing pressure.

Coupland described the *Stipa-Bouteloua-Agropyron* as being the most common community type on the brown medium-textured soils of the Dry-Mixedgrass and on the driest of medium-textured soils in the dark brown soil zone. Needle-and-thread grass and blue grama grass are more common and the cover of the other mid-grasses declines (Coupland 1973). Like blue grama, June grass and low sedges are important interstitial species that may become more common with heavy grazing pressure and/or on sites with soil limitations. Four mid-grasses including needle-and-thread grass, western porcupine grass, northern and western wheatgrass make up about 50 to 60 % of the forage yield (Couplant 1973). Other short growing species provide most of the balance of forage yield. Blue grama provides about 15 to 30 % and June grass just under 10 % (Coupland 1973).

Coupland (1973) also recognized grasslands types associated with solonetzic soils also referred to as hard-pan or blowout ranges sites. He suggested that *Agropyron-Bouteloua* was perhaps a better name than his original *Bouteloua-Agropyron* naming, given the adaptation of wheatgrasses to the condition of expanding clays and soil cracking associated with solonetzic soils.

Silver sagebrush provides valuable plant community structure for many wildlife species in the dry mixed grass prairie environment. Weerstra (2002) has developed a preliminary classification of silver sagebrush (*Artemisia cana*) community types for the Grassland Natural Region of Alberta. The initial classification includes nine herbaceous-shrub types and three shrub types. An important community described in Weerstra's review includes a major shrub type, Silver Sagebrush/Western Wheatgrass (*Artemisia cana/Agropyron smithii*), which was defined by Thompson and Hansen (2002) in the development of a riparian plant community classification for the Grassland Natural Region of Alberta. Thorpe and Godwin (2003) noted that *Agropyron smithii* was not always the dominant wheatgrass in silver sagebrush plant communities in southwestern Saskatchewan and that *Agropyron dasystachyum* would often share dominance with no obvious environmental reason. Adams et al. (2004) describe six silver sagebrush shrub communities in the sage grouse area of southeastern Alberta which are integrated into the results of this report. See Thorpe (1997) for a thorough over view of silver sagebrush communities in a broader prairie context.

Significant tracts of sandhill and sand plain land landscapes occur within the Dry Mixedgrass. Coenen and Bentz (2002) described 17 plant communities within the Pawkowki sandhills including one tree type, 6 shrub communities, four perennial forb types and six graminoid types. Grassland communities were distinguished from other heavier textured soils by the presence of *Calamovilfa longifolia (sandgrass) Oryzopsis hymenoides (Indian ricegrass) and Sporobolus cryptandrus* (sand dropseed) all reliable indicators of coarse and very coarse textured soils.

4.2 Modified Plant Communities

There is growing awareness and concern about the impact of invasive agronomic grasses on native plant communities. Research in the past 20 years has raised particular concern about the use of crested wheatgrass as a seeded tame forage species. Crested wheatgrass has had considerable value in facilitating complementary grazing of tame and native forages by permitting spring deferral of grazing on native range thus promoting the full growth potential of the native pasture. However, a number of studies raise serious questions about the long-term sustainability of grassland soils when seeded to tame forage species like crested wheatgrass and Russian wildrye. Seeded species do not support the same soil environment as native species and soil quality tends to decline over time (Willms and Jefferson 1993). A variety of soil related impacts have been reported.

Crested wheatgrass releases less carbon into the rhizosphere than do native species like western wheatgrass and blue grama (Biondini et al. 1988). When compared to adjoining native rangeland, 23 year old seedings of crested wheatgrass and Russian wildrye had lower levels of soil organic matter, lower pH and lower root mass (Smoliak and Dormaar 1985). Similar results were reported for seeded sites of crested wheatgrass or Russian wildrye with wide row spacings (55 to 75 cm) which had been established for 20 to 25 years (Dormaar et al. 1994). Conversion of native prairie to tame species resulted in lower physical stability of the soil by decreasing root mass and organic matter.

The concern about crested wheatgrass goes beyond its impact on seeded sites. Crested wheatgrass invasion of grassland communities has become widespread (Bradley et al. 2003). Henderson and Naeth (2004) have documented the reduction in community and landscape levels of diversity with crested wheat invasion. While major soil properties appeared unchanged, cool season mid grasses and forbs were lower in abundance following invasion. Crested wheatgrass appears to invade through abundant seed production and more aggressive use of soil moisture in contrast to native species (Henderson and Naeth 2004).

Analysis of plot data from the Grassland Natural Region reveals the presence of invasive agronomics in trace amounts (Table 8). Kentucky bluegrass was present in 32% of plots, followed by awnless brome at 6%, crested wheatgrass at 4% and Timothy at 2%. The presence of these species in native vegetation may increase the risk of further invasion following soil disturbance by various land use practices as well as from overgrazing.

Table 8 Percent frequency of invasive agronomic grasses in range vegetation inventory plots within the grassland natural region including the Dry Mixedgrass Natural Subregion.

Natural Subregion n=sample plots	**Timothy**	**Awnless brome**	**Kentucky bluegrass**	**Crested Wheatgrass**
Dry Mixedgrass n=1716	**0**	**T**	**5**	**2**
Mixedgrass n=724	2	6	32	4
Foothills Fescue n=283	36	7	68	T
Foothills Parkland n=410	73	21	75	T

[1] Frequency means species are present in plots but does not imply infestation levels of the species in the transect· Native Prairie Data Base, Public Lands and Forest Division Division, Alberta Sustainable Resource Development, Lethbridge

5.0 Classification Methods

5.1 Plant Community Classification Methods

Data for this analysis consisted mostly of range survey and rangeland reference area data collected by Alberta Sustainable Resource Development from 1986 until present. A total of 1716 vegetation inventory forms were analyzed. All data records were reviewed for completeness, species seven letter codes were assigned along with a unique identifier number for each transect. The data were then entered into the Prairie Data Base (Rangeland Management Branch, Alberta Sustainable Resource Development, Lethbridge). The data base calculates mean values for species composition, total vegetation, moss/lichen and bare soil cover.

The results of vegetation transect queries were extracted from the Prairie Data Base and formatted for analysis in a two dimensional matrix in the *.wk1 format that PC-ORD requires. Ordination and classification studies were carried out on the data sets using PC-ORD (MJM Software, Gleneden Beach, Oregon). The corresponding land data including soils and site information, were sorted into a corresponding land data matrix.

In order to establish major plant community types ordination and classification interpretations were developed by using two statistical procedures (Willoughby 1997):

> a) De-trended Correspondence Analysis was applied (Gauch 1982). This procedure compares similarity and dissimilarity among sites. Plotting of the ordination scores in three dimensional “species space”, allows viewing of site and species distributions and facilitates grouping of sites by community types.
>
> b) A cluster analysis procedure was employed as an alternate grouping technique to compare and contrast with the results of the DCA procedure. Ward’s method of cluster analysis was the most easily interpreted from the six or more procedure that might be chosen.

Plant community type summaries were generated in Quattro Pro, by averaging plant species composition, range in composition and percent constancy of occurrence among groups of vegetation inventory plots considered to form a unique plant community type. Environmental data was subsequently sorted into the same plant community groups as described above for further analysis and correlation with plant community groupings. Total vegetation canopy cover, moss/lichen and bare soil estimates were also calculated for the plant community type groupings of vegetation inventory plots. The resulting plant community descriptions are reported in one page summaries similar to those used by Willoughby et al. (2003).

Ecologically sustainable stocking rates (ESSR) values are suggested for each plant community(Table 10). These values reflect the maximum number of livestock (e.g.Animal Unit Months (AUM)/acre) that can be supported by the plant community given inherent biophysical constraints and the ecological goal of sustainable health and proper functioning of the plant community. When the ESSR is multiplied by the area (e.g. acres) of a plant community polygon the result is termed **ecologically sustainable carrying capacity (ESCC)**, and is expressed as AUMs. At times, the ESCC must be adjusted for management factors (e.g. reduced livestock distribution), management goals (e.g. improve rangeland health, multiple use and values, etc.), drought conditions, and other natural phenomena impacting the site (e.g. forage quality, fire, pests, etc.). This adjusted/reduced value is the **ecologically sustainable grazing capacity (ESGC)**. The ESGC values are not provided in the plant community guide because the necessary adjustments are determined by the rangeland resource manager.

Suggested ESSR values (Table 10) may be determined from a combination of forage yield clipping studies, long-term rangeland reference area data, estimated production, and historical grazing experience. In order to sustain ecological health and function of the plant community, the ESSR was based on historical grazing rates where the information was available and on forage yield data, when historic grazing records were not available. A number of assumptions underlie the development of ESSRs:

- Ecologically sustainable forage utilization levels are set between 25 % to 50% total herbage production for grassland plant community types and the forage requirements of one animal unit (i.e. 455 kg of dry matter per month).
- The remaining biomass production (carry over), is allocated for the maintenance of ecological functions (e.g. nutrient cycling, viable diverse plant communities, hydrological function, and soil protection, etc.) and plant community services (forage production, habitat maintenance, etc.).
- The allocation of biomass production in this manor is well established, and supported, by the scientific community and the amount required, varies with Natural Subregion (Holechek et al. 1995).

In this study, the historical grazing records and forage productivity data were correlated in establishing ecologically sustainable stocking rate (ESSR) values through the following steps:

- A ranking was made of major reference plant communities by ecological range site, based on productivity data where available, from rangeland reference areas.

- Existing ESSR estimates were correlated with the appropriate range sites from Wroe et al. 1988.

- New carrying capacity data were summarized from grazing records on file for selected grazing dispositions that typify a particular plant community.

- A review team of experienced field staff then reviewed the suggested carrying capacity values and modified carrying capacity estimates where appropriate.

- In the absence of grazing records, and especially with minor plant community types that normally have a small area of occurrence on the landscape, forage yield data or forage yield estimates were applied to derive an ESSR.

6.0 Results and Discussion

The analysis evaluated 1716 vegetation plots and distinguished 45 plant communities of which 39 were native grassland types and six were shrub types. The reference plant communities are listed by ecological range site in Table 9 for all ecodistricts. The reference plant communities are also grouped with their corresponding successional plant communities in Table 9.

Suggested ecologically sustainable stocking rate values and ranges are provided for the same series of geographic areas in Tables 10. Each of the 45 plant communities are summarized on pages 40-85. As additional data become available, a number of unclassified plots will be reconsidered in future refinements of this guide.

Plant communities were defined for 13 range site types including overflow, clayey, loamy, sandy, blowout, sands, choppy sandhills, shallow-to-gravel, limy, gravel, thin breaks, saline lowlands and badlands. These range sites were further subdivided into 30 ecological range sites, which are an expression of variability within range site types as expressed by unique plant community types (Table 9).

A number of major range site categories warrant further description:

Overflow range sites are expressed in three major groups (Table 9): Overflow 1 and 2 tend to have non to low salinity levels with western porcupine grass being the dominant graminoid, a species with a relatively low tolerance to salts. Overflow categories 3 and 4 are classic saline overflow sites with western wheatgrass and silver sagebrush being species adapted to saline overflow at higher concentrations. Finally overflow 5 is likely both saline and sodic, a soil chemistry regime that greasewood is adapted to.

Clayey range sites tend to be dominated by western wheatgrass and in some cases prickly pear cactus. The root systems of both species are adapted to the soil swelling and shrinking processes that characterize clayey soils. The root systems of needle and thread are unable to withstand these mechanical forces.

Loamy range sites can be grouped into three categories to assist in their identification in the field. Range site categories Loamy 1, 2 and 3 are associated with **moist loamy** soils. Moist loamy range sites are generally found at the higher elevations of the Dry Mixedgrass, in areas adjoining the Mixedgrass Subregion. Specific soil series associated with moist loamy range sites include: Cranford, Maisinisin and Pinhorn. Under light disturbance regimes, moist loamy range sites will have a high proportion of taller mid-grass species like northern and western wheatgrass and western porcupine grass. By far the most extensive loamy type is Loamy 4, described as **loamy-typical** occurring at medium to lower elevations within the subregion on medium textured soils like Chin, Foremost and Maleb. Plant communities tend to be dominated by needle-and-thread, blue grama and June grass. Loamy 5 is a **dry loamy** type, and is associated with those loamy AGRASID polygons with the soil unit numbers 7, 10, 14, 15 and 17. These are soil units with additional soil limitations modifying the loamy character of the soil (solonetzic, coarser, rego, eroded). Examples of associated soil series include Ronalaine and Tilley.

Blowout range sites (Table 9) are associated with a number of other important range site types including **saline lowlands** and **overflow** range sites (Figure 4, page 12). The figure shows a valley-basin soil series sequence and a continuum as soils develop from least to most mature:

- Saline lowland range sites occur on the far left side of figure 4(saline phase gleyed regosol), where the combination of salts, heavy clay soils, poor internal drainage and periodic ponding of water, limit soil development. Range sites like Saline Lowland 1 and 2 would be common to this soil regime. Plant species are salt tolerant and considerable bare soil may be normally present on the range site.

- Moving slightly to the right on figure 4 (orthic regosol), improved internal drainage with frequent additions of water as overland flow, including salts and sediments, provides overflow conditions associated with range site Overflow 4. These conditions produce the classic silver sagebrush/western wheatgrass community type. Soils are juvenile due to frequent sediment additions.

- As soil drainage further improves(brown solonetz), the impervious hardpan layer associated with brown solonetzic soils is expressed in range sites like Blowout 5.

- As soils further mature and as the hardpan layer begins to break down in solodized solonetz and solod phases, Blowout types 1 through 4 would be expected. Important plant indicators on brown solonetzic soils include wheatgrasses, June grass and sagebrush. An important distinction between Blowout types 1-4 vs. 5 is in the amount of bare soil that occurs naturally. Soil exposure is often 30 to 50% for Blowout 5, but 15% or less for Blowout types 1-4 where the breakdown of the hardpan layer and improved rooting potential permits the development of greater vegetation canopy. As the hardpan layer begins to break down towards the brown solod stage, bunch grass species like needle and thread grass begin to occupy more and more of the range site.

- Finally, as the hardpan layer is essentially ameliorated, as represented on the far right side of figure 4(solonetzic brown and orthic brown chernozem), the range site will eventually express itself as range site Loamy 5, with only remnant features of the original soloneztic character.

Table 9. Plant communities listed by ecological range site within the Dry Mixed Grass Natural Subregion

Ecological Range Site	Range Plant Community (Reference Plant Community)	Successional Community Types	Modified Plant Communities
Overflow 1	DMGA1 Snowberry/Western Porcupine Grass - Needle and Thread		
Overflow 2	DMGC3 Silver Sagebrush/Western Porcupine Grass-Wheatgrass		
Overflow 3	DMGA40 Western Wheatgrass-Low Sedge-Green Needle Grass	DMGA41 Low Sedge-Western Wheatgrass-Green Needle Grass	
Overflow 4	DMGC1 Silver Sagebrush/ Western Wheatgrass	DMGA45 Western Wheat Grass - Salt Grass - Gumweed	
Overflow 5	DMGC7 Greasewood/ Salt Grass - Western Wheat Grass		
Clayey 1	DMGA8 Western Wheat Grass-Pasture Sagewort-Prickly Pear Cactus		
Loamy 1	DMGA9 Needle and Thread - Thread-leaved Sedge		
Loamy 2	DMGA2 Needle and Thread - Wheatgrass	DMGA46 Needle and Thread - Blue Grama - Wheatgrass DMGA47 Needle and Thread - Blue Grama -Northern-Wheatgrass DMGA48 Blue Grama - Needle and Thread	
Loamy 3	DMGA5 Needle and Thread - Northern - Wheatgrass - Plains Reed Grass		
Loamy 4	DMGA3 Needle and Thread - June grass - Blue Grama Grass	DMGA10 Blue Grama Grass - Needle and Thread Grass	

Ecological Range Site	Range Plant Community (Reference Plant Community)	Successional Community Types	Modified Plant Communities
Loamy 5	DMGA12 Silver Sagebrush/Needle and Thread - Blue Grama Grass		
Sandy 1	DMGA13 Western Porcupine Grass-Needle and Thread-Sand Grass		
Sandy 2	DMGA14 Western Wheat Grass - Needle and Thread		
Blowout 1	DMGA35 Needle and Thread-June Grass-Blue Grama Grass		
Blowout 2	DMGA15 Wheat Grass-Needle and Thread-June Grass		
Blowout 3	DMG16 Western Wheat Grass-Sedge-Needle and Thread		
Blowout 4	DMGA17 Needle and Thread - Sandberg Bluegrass		
Blowout 5	DMGA39 Wheatgrass - Sandberg Bluegrass	DMGA30 Sandberg Bluegrass-Northern Wheat Grass	
Blowout 6	DMGA34 Silver Sagebrush/Northern Wheat Grass - June Grass-Blue Grama Grass	DMGA31 Silver Sagebrush/Sandberg Bluegrass-June Grass	

Ecological Range Site	**Range Plant Community (Reference Plant Community)**	**Successional Community Types**	**Modified Plant Communities**
Sands 1	DMGA18 Silver Sagebrush/Needle and Thread-Blue Grama Grass-June Grass		
Sands 2	DMGA43 Needle and Thread-Low Sedge-Sand Grass	DMGA19 Silver Sagebrush/Needle and Thread-Sand Grass	
Choppy Sandhills 1	DMGC5 Wild Rose/Needle and Thread-Sand Grass-Low Sedge	DMGC6 Choke Cherry/Northern Wheatgrass-June Grass DMGA32 Needle and Thread-Wild Licorice	
Shallow to Gravel	DMGA37 Silver Sagebrush/Needle and Thread-Blue Grama Grass-June Grass	DMGA38 Needle and Thread-Pasture Sagewort	
Limy	DMGA24 Silver Sagebrush/Needle and Thread-Western Wheat Grass-Blue Grama Grass		
Gravel	DMGA23 Silver Sagebrush/Needle and Thread-Blue Grama Grass-June Grass	DMGA33 Needle and Thread-Pasture Sagewort	
Thin Breaks 1	DMGA22 Needle and Thread-Blue Grama Grass-June Grass		
Thin Breaks 2	DMGA42 Needle and Thread-Blue Grama - Low Sedge		
Saline Lowlands 1	DMGA20 Western Wheat Grass-Sedge		
Saline Lowlands 2	DMG A21 Silver Sagebrush/ Wheatgrass - Nuttall's Atriplex	DMGA44 Salt Grass - Western Wheatgrass	

Ecological Range Site	Range Plant Community (Reference Plant Community)	Successional Community Types	Modified Plant Communities
Badlands 1	DMGA36 Blue Grama Grass-Salt Grass-Needle and Thread		
Badlands 2	DMGC4 Creeping Juniper/Undifferentiated Sedge		

Table 10. Range plant communities listed by ecological range site within the Dry Mixed Grass Natural Subregion

Community Number (Range Site)	Community Type (**RPC(reference plant community)**, Successional, *Modified*)	ESSR AUM's/Acre	ESSR Range AUM's/Acre	ESSR acres/AU	ESSR Range acres/AU
DMGA1	**Snowberry/Western Porpcupine Grass - Needle and Thread**	0.34	0.3-0.4	35	30-40
Overflow 1					
DMGC3	**Silver Sagebrush/Western Porcupine Grass-Wheatgrass**	0.3	0.25-0.35	40	34-48
Overflow 2					
DMGA40	**Western Wheatgrass-Low Sedge-Green Needle Grass**	0.30	0.25-0.35	40	34-48
DMGA41	Low Sedge-Western Wheatgrass-Green Needle Grass	0.26	0.23-0.29	46	42-52
Overflow 3					
DMGC1	**Silver Sagebrush/Western Wheatgrass**	0.23	0.2-0.26	52	46-50
DMGA45	Western Wheat Grass - Salt Grass - Gumweed	0.20	0.15-0.25	60	48-80
Overflow 4					
DMGC7	**Greasewood - Salt Grass - Western Wheat Grass**	0.15	0.13-0.17	80	71-92
Overflow 5					
DMGA8	**Western Wheat Grass-Pasture Sagewort-Prickly Pear Cactus**	0.23	0.17-0.28	52	43-70
Clayey 1					
DMGA9	**Needle and Thread - Thread-leaved Sedge**	0.25	0.23-0.29	48	42-52
Loamy 1					
DMGA2	**Needle and Thread - Wheatgrass**	0.24	0.22-0.27	50	45-55
DMGA46	Needle and Thread - Blue Grama - Wheatgrass	0.2	0.18-0.23	60	52-70
DMGA47	Needle and Thread - Blue Grama - Northern Wheatgrass	0.18	0.17-0.21	65	58-75
DMGA48	Blue Grama - Needle and Thread	0.15	0.13-0.17	80	70-90
Loamy 2					
DMGA5	**Needle and Thread - Northern - Wheatgrass - Plains Reed Grass**	0.22	0.2-0.25	55	48-60
Loamy 3					
DMGA3	**Needle and Thread - June grass - Blue Grama Grass**	0.20	0.16-0.22	60	55-75
DMGA10	Blue Grama Grass - Needle and Thread Grass	0.15	0.12-0.17	80	70-100
Loamy 4					

Community Number (Range Site)	Community Type (**RPC(reference plant community)**, Successional, *Modified*)	**ESSR AUM's/Acre**	**ESSR Range AUM's/Acre**	**ESSR acres/AU**	**ESSR Range acres/AU**
DMGA12 **Loamy 5**	**Silver Sagebrush/Needle and Thread - Blue Grama Grass**	0.18	0.15-0.20	67	60-80
DMGA13 **Sandy 1**	**Western Porcupine Grass-Needle and Thread-Sand Grass**	0.23	0.2-0.25	52	48-60
DMGA14 **Sandy 2**	**Western Wheat Grass - Needle and Thread**	0.22	0.18-0.24	55	50-65
DMGA35 **Blowout 1**	**Needle and Thread-June Grass-Blue Grama Grass**	0.18	0.16-0.20	65	58-75
DMGA15 **Blowout 2**	**Wheat Grass-Needle and Thread-June Grass**	0.16	0.14-0.18	75	67-85
DMGA16 **Blowout 3**	**Western Wheat Grass-Sedge-Needle and Thread**	0.15	0.13-0.17	80	71-92
DMGA17 **Blowout 4**	**Needle and Thread - Sandberg Bluegrass**	0.14	0.12-0.16	86	75-100
DMGA39 DMGA30 **Blowout 5**	**Wheatgrass - Sandberg Bluegrass** Sandberg Bluegrass-Northern Wheat Grass	0.11 0.08	0.10-0.13 0.06-0.1	105 140	90-120 120-200
DMGA34 DMGA31 **Blowout 6**	**Silver Sagebrush/Northern Wheat Grass - June Grass - Blue Grama Grass** Silver Sagebrush/Sandberg Bluegrass-June Grass	0.09 0.06	0.08-0.12 0.04-0.08	126 200	100-140 140-300
DMGA18 **Sands 1**	**Silver Sagebrush/Needle and Thread-Blue Grama Grass-June Grass**	0.17	0.16-0.18	70	65-75

Community Number (Range Site)	Community Type (**RPC(reference plant community)**, Successional, *Modified*)	ESSR AUM's/Acre	ESSR Range AUM's/Acre	ESSR acres/AU	ESSR Range acres/AU
DMGA43	**Needle and Thread - Low Sedge-Sand Grass**	0.16	0.14-0.18	75	65-85
DMGA19	Silver Sagebrush/Needle and Thread-Sand Grass	0.15	0.13-0.16	80	75-90
Sands 2					
DMGC5	**Wild Rose/Needle and Thread-Sand Grass-Low Sedge**	0.15	0.13-0.16	80	75-90
DMGC6	Choke Cherry/Northern Wheatgrass-June Grass	0.16	0.15-0.17	75	70-80
DMGA32	Needle and Thread - Wild Licorice	0.15	0.13-0.18	80	67-92
Choppy Sandhills 1					
DMGA37	**Silver Sagebrush/Needle and Thread-Blue Grama Grass-June Grass**	0.17	0.15-0.19	70	62-80
DMGA38	Needle and Thread-Pasture Sagewort	0.15	0.13-0.17	80	71-92
Shallow to Gravel					
DMGA24	**Silver Sagebrush/Needle and Thread-Western Wheat Grass-Blue Grama Grass**	0.18	0.15-0.21	67	58-80
Limy					
DMGA23	**Silver Sagebrush/Needle and Thread-Blue Grama Grass-June Grass**	0.15	0.13-0.17	80	71-92
DMGA33	Needle and Thread-Pasture Sagewort	0.1	0.08-0.12	120	100-150
Gravel					
DMGA22	**Needle and Thread-Blue Grama Grass-June Grass**	0.1	0.08-0.12	120	100-150
Thin Breaks 1					
DMGA42	**Needle and Thread-Blue Grama - Low Sedge**	0.1	0.08-0.12	120	100-150
Thin Breaks 2					
DMGA20	**Western Wheat Grass-Sedge**	0.15	0.13-0.17	80	71-92
DMGA44	Salt Grass - Western Wheatgrass	0.12	0.1-0.13	100	92-110
Saline Lowlands 1					
DMGA21	**Silver Sagebrush/Wheatgrass - Nuttall's Atriplex**	0.05	0.4-.06	235	200-300
Saline Lowlands 2					

Community Number (Range Site)	**Community Type** (**RPC(reference plant community)**, Successional, *Modified*)	**ESSR AUM's/Acre**	**ESSR Range AUM's/Acre**	**ESSR acres/AU**	**ESSR Range acres/AU**
DMGA36 **Badlands 1**	**Blue Grama Grass-Salt Grass-Needle and Thread**	0.1	0.05-0.15	120	80-240
DMGC4 **Badlands 2**	**Creeping Juniper/Undifferentiated Sedge**	0.05	0.4-0.6	235	200-300

Western Porcupine Grass - Needle and Thread **DMGA1**

(Stipa curtiseta - Stipa comata) Herbaceous

n=20 This is a reference plant community for overflow and very productive loamy range sites in the Dry Mixedgrass, likely in transition areas to the Mixedgrass when western snowberry is present. In the case of overflow sites, both the site and overflow are likely non-saline given the cover of both western porcupine grass and needle-and-thread grass which are relatively intolerant of salinity. The presence of such vigorous and productive cover of western porcupine grass is an indicator of productive, dark brown chernozemic soils (Smoliak, Personal comm.). This type is restricted to bottom slope positions, fans, aprons and channels where soil moisture is superior and where overland flow enhances the local moisture supply. This community type occurs in association with the soils listed below but is more productive in character. Note the high canopy cover of total vegetation and low percentage of soil exposure.

Soil Exposure: 4 % (0-16)**Moss/Lichen Cover:** 12 % (0-47) **Total Vegetation:** 82% (0-98%)

Plant Composition Canopy Cover(%)

	Mean	Range	Const
Shrubs			
Buckbrush *(Symphoricarpos occidentalis)*	7	0-26	50
Forbs			
Pasture Sagewort *(Artemisia frigida)*	1	0-8	65
Death Camas *(Zigadenus venenosus)*	1	0-4	60
Wild Vetch *(Vicia americana)*	1	0-7	45
Grasses			
Western Porcupine Grass *(Stipa curtiseta)*	41	20-59	100
Needle-and-Thread *(Stipa comata)*	12	0-41	85
Undifferentiated Sedge *(Carex)*	7	0-30	75
Western Wheat Grass *(Agropyron dasystachyum)*	6	0-18	60
June Grass *(Koeleria macrantha)*	4	0-13	65
Northern Wheat Grass *(Agropyron dasystachyum)*	4	0-16	40
Blue Grama Grass *(Bouteloua gracilis)*	2	0-6	45
Sandberg Bluegrass *(Poa sandbergii)*	1	0-9	45

Environmental Variables

Range Site:
Overflow

Soils:
Orthic Brown (foremost, maleb, cranford)
Brown Solod (gem)

Soil Drainage:
Well drained

Slope :
Very gentle
Moderate

Aspect:
southerly

Forage Production (lb/ac)

Grass	Not Available
Forb	Not Available
Shrub	Not Available
Litter	Not Available
Total	Not Available

Ecologically Sustainable Stocking Rate
0.34 AUM/ac

Needle and Thread - Wheat Grasses DMGA2

(Stipa comata - Agropyron spp.) Herbaceous

n=39 This is a reference plant community on loamy range sites in the Dry Mixed grass on productive mid to lower slope locations and on north facing slopes where growing conditions may be slightly moister. This community is also generally associated with soils of the moist loamy range sites in the Dry Mixedgrass subregion including Crandford, Maisinisin and Pinhorn. This community is distinguished by a high proportion of northern or western wheatgrass and is therefore quite productive. As grazing pressure increases, northern and western wheatgrass will decline in abundance. Under long-term moderate to moderate heavy grazing, this community type will resemble DMGA3 and so recognizing the higher quality of soil and growing conditions is important. Like DMGA9, this community provides superior forage productivity compared to DMGA3 and DMGA12 with grass yields likely averaging 750-850 lb/ac.

Soil Exposure: 9% (0-45) **Moss/Lichen Cover:** 42 % (0-76) **Total Vegetation:** 76% (48-87%)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
FORBS			
SILVER SAGEBRUSH *(Artemisia cana)*	1	0-22	21
FORBS			
PASTURE SAGEWORT *(Artemisia frigida)*	5	0-14	90
SCARLET MALLOW *(Sphaeralcea coccinea)*	2	0-9	74
GRASSES			
NEEDLE-AND-THREAD *(Stipa comata)*	23	6-47	100
WHEATGRASS *(Agropyron)*	22	10-51	100
BLUE GRAMA GRASS *(Boutelua gracilis)*	13	0-38	97
JUNE GRASS *(Koeleria macrantha)*	13	0-34	92
UNDIFFERENTIATED SEDGE *(Carex)*	3	0-14	56
SANDBERG BLUEGRASS *(Poa sandbergii)*	3	0-17	69
WESTERN PORCUPINE GRASS *(Stipa curtiseta)*	1	0-14	15
PLAINS REED GRASS *(Calamagrostis montanensis)*	1	0-9	38

ENVIRONMENTAL VARIABLES

RANGE SITE:
LOAMY

SOILS: ORTHIC BROWN (CRANFORD, FOREMOST, MALEB)
ORTHIC DARK BROWN (PURESCAPE)

SOIL DRAINAGE:
WELL DRAINED
MODERATELY WELL DRAINED

SLOPE :
VERY GENTLE
NEARLY LEVEL
GENTLE

ASPECT:
NORTHERLY

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.24AUM/ac

Needle and Thread - June Grass - Blue Grama Grass **DMGA3**

(Stipa comata - Koeleria macrantha - Bouteloua gracilis) Herbaceous

n=371 This is a reference plant community on well drained loamy range sites in the Dry Mixedgrass. This is perhaps the most common grassland community type in the brown soil zone and corresponds with the community that Coupland(1961) described as the Stipa-Boutelua faciation. This type is considered the late seral to reference plant community for these soils given the dominance of mid-grasses like Needle-and-Thread and the presence of northern and western wheatgrass (Coupland 1950, 1961, 1973). Coupland (1961) challenged the interpretation of previous studies (Clark et al. 1942, Hubbard 1950) that described this as a Bouteloua- Stipa community implying a "short grass" prairie designation. Coupland (1961) concluded that the loamy soils in the brown soil zone would normally support mixed grass communities. Early studies were likely carried out after decades of heavy grazing had reduced the prominence of midgrasses. Coupland observed the prairie decades later when midgrass vegetation was beginning to reestablish dominance. In terms of grazing management, heavy grazing pressure will first lead to a decline in wheatgrass cover and eventually needle-and-thread will be replaced by more grazing resistant speceis like blue grama, Sandberg bluegrass and sedges. Forage production data presented below is a 10 year average from the now defunct Hays rangeland reference area with this community type and a Maleb soil series.

Soil Exposure: 12 % (1-59) **Moss/Lichen Cover:** 40 % (0-98) **Total Vegetation:** 62% (20-92%)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
FORBS			
SILVER SAGEBRUSH *(Artemisia cana)*	1	0-13	30
FORBS			
PASTURE SAGEWORT *(Artemisia frigida)*	5	0-28	88
SCARLET MALLOW *(Sphaeralcea coccinea)*	1	0-23	33
GRASSES			
NEEDLE-AND-THREAD *(Stipa comata)*	42	4-85	100
JUNE GRASS *(Koeleria macrantha)*	14	0-44	99
BLUE GRAMA GRASS *(Boutelua gracilis)*	11	0-51	95
UNDIFFERENTIATED SEDGE *(Carex)*	6	0-25	94
WESTERN WHEAT GRASS *(Agropyron smithii)*	6	0-38	80
PLAINS REED GRASS *(Calamagrostis montanensis)*	1	0-15	53
SANDBERG BLUEGRASS *(Poa sandbergii)*	1	0-22	45
NORTHERN WHEAT GRASS *(Agropyron dasystachyum)*	2	0-29	26

ENVIRONMENTAL VARIABLES

RANGE SITE:
LOAMY

ELEVATION (M):
793 (741-907)

SOILS: ORTHIC BROWN (BINGEVILLE, CRANFORD, MALEB, CHIN, ANTONIO)
SOLONETZIC BROWN (RONALAINE)

SOIL DRAINAGE:
WELL DRAINED, MODERATELY WELL DRAINED, RAPIDLY DRAINED

SLOPE :
VERY GENTLE, NEARLY LEVEL
GENTLE

ASPECT:
VARIABLE

FORAGE PRODUCTION (LB/AC)

GRASS	479 (301-598)
FORB	22 (1-59)
TOTAL	501
LITTER	338 (131-600)

Ecologically Sustainable Stocking Rate
0.20 AUM/ac

Needle and Thread - Northern Wheat Grass - Plains Reed Grass

DMGA5

(Stipa comata - Agropyron dasystachyum - Calamagrostis montanensis) Herbaceous

n=51 This is a late-seral reference plant community where loamy range sites intermix with particular solonetzic soils and are difficult to distinguish by normal features like blowout expression. This plant community occurs on brown chernozemic soils intermixed with solonetzic browns and brown solods and is particularly common in the the Wildhorse Plain. Growing conditions improve on solonetzic soils as their soil development approaches that of loamy sites. This factors is reflected in the relatively low soil exposure associated with this community type (7%). A key indicator species is plains reedgrass which occurs with at about 10% of composition.

Soil Exposure: 7 % (1-24)**Moss/Lichen Cover:** 34 % (5-79) **Total Vegetation:** 77% (57-95%)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
FORBS			
PASTURE SAGEWORT *(Artemisia frigida)*	3	0-14	82
COMMON DANDELION *(Taraxacum officinale)*	2	0-15	82
COMMON GOAT'S BEARD *(Tragopogon dubius)*	1	0-6	69
GRASSES			
NEEDLE-AND-THREAD *(Stipa comata)*	24	11-48	100
NORTHERN WHEATGRASS *(Agropyron dasystachyum)*	23	6-47	100
PLAINS REED GRASS *(Calamagrostis montanensis)*	10	0-29	98
JUNE GRASS *(Koeleria macrantha)*	8	11-21	100
BLUE GRAMA GRASS *(Boutelua gracilis)*	6	0-16	96
WESTERN WHEAT GRASS *(Agropyron smithii)*	4	0-21	67
THREAD-LEAVED SEDGE *(Carex filifolia)*	2	0-14	35
UNDIFFERENTIATED SEDGE *(Carex)*	1	0-9	73
SANDBERG BLUEGRASS *(Poa sandbergii)*	1	0-9	59

ENVIRONMENTAL VARIABLES

RANGE SITE:
LOAMY

SOILS:
ORTHIC BROWN (PINHORN,COMREY)
SOLONETZIC BROWN, BROWN SOLOD

ELEVATION (M):
956 (937-975)

SOIL DRAINAGE:
WELL DRAINED
MODERATELY WELL DRAINED

SLOPE :
VERY GENTLE AND LEVEL

ASPECT:
VARIABLE

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.22 AUM/ac

Western Wheat Grass - Pasture Sagewort -Prickly Pear Cactus

DMGA8

(Agropyron smithii - Artemisia frigida-Opuntia polyacantha) Herbaceous

n=11 This is a reference plant community on clayey range sites in the Dry Mixedgrass. This community type was described previously by Coupland (1961) as Agroyron-Koeleria, but have used prickly-pear cactus since the species serves as an excellent indicator species. Developed on fine textured lacustrine clay soils, much of the range site has been cultivated due to the superior moisture holding capacity of the soils. Spear grass species like porcupine grass and needle-and-thread are largely absent from this range site since they appear poorly adapted to the swelling and shrinking properties of the soil. Little specific productivity and management information is available about this range site and future studies are recommended. These soils tend to have a high proportion of exposed soil.

Soil Exposure: 38 % (1-83) **Moss/Lichen Cover:** 12 % (1-26) **Total Vegetation:** 58% (36-88)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
SHRUBS			
NUTTALL'S ATRIPLEX *(Atriplex nuttallii)*	2	0-11	36
FORBS			
PASTURE SAGEWORT *(Artemisia frigida)*	2	0-10	82
PRICKLY PEAR CACTUS *(Opuntia polyacantha)*	2	0-12	36
SCARLET MALLOW *(Sphaeralcea coccinea)*	1	0-3	64
GRASSES			
WESTERN WHEAT GRASS *(Agropyron smithii)*	42	22-85	100
SANDBERG BLUEGRASS *(Poa sandbergii)*	13	0-26	82
BLUE GRAMA GRASS *(Bouteloua gracilis)*	7	0-25	73
JUNE GRASS *(Koeleria macrantha)*	5	0-16	82
UNDIFFERENTIATED SEDGE *(Carex)*	5	0-28	73
NEEDLE-AND-THREAD *(Stipa comata)*	4	0-17	55
FOXTAIL BARLEY *(Hordeum jubatum)*	2	0-13	27
GREEN NEEDLE GRASS *(Stipa viridula)*	1	0-14	18

ENVIRONMENTAL VARIABLES

RANGE SITE:
- CLAYEY

ELEVATION (M):
- 868 (846-893)

SOILS:
- ORTHIC REGOSOLIC (ORION)
- BROWN SOLODIZED SOLONETZ (WARDLOW, HEMARUKA)
- ORTHIC BROWN (FOREMOST)

SOIL DRAINAGE:
- WELL DRAINED
- MODERATELY WELL DRAINED

SLOPE :
- VERY GENTLE
- NEARLY LEVEL
- GENTLE

ASPECT:
- SOUTHERLY

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.23 AUM/ac

Needle and Thread - Thread-Leaved Sedge DMGA9

(Stipa comata - Carex filifolia) Herbaceous

n=23 This is a reference plant community on loamy range sites at upper elevations in the Dry Mixedgrass in areas that are transitional to the Mixedgrass. This type is commonly found Pinhorn and Masinasin soils with soil textures tending towards sandy loam. The community is distinguished by a high proportion of Thread-Leaved Sedge in place of what normally would be expected to be Northern or Western wheatgrass as the major sub-dominants in transition to the Mixedgrass. Thread-Leaved sedge is normally a decreaser species and would be expected to decline in canopy cover as grazing pressure increases above sustainable levels. This is probably one of the most productive loamy community types in the Dry Mixedgrass, with mean grass yields of 1149 lb/ac a monitored at the Pinhorn rangeland reference area.

Soil Exposure: 21% (1-53) **Moss/Lichen Cover:** 19 % (1-58) **Total Vegetation:** 72% (43-98%)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
FORBS			
PASTURE SAGEWORT *(Artemisia frigida)*	2	0-8	61
COMMON DANDELION *(Taraxacum officinale)*	1	0-7	35
GRASSES			
NEEDLE-AND-THREAD *(Stipa comata)*	38	14-62	100
THREAD-LEAVED SEDGE *(Carex filifolia)*	21	10-36	100
BLUE GRAMA GRASS *(Boutelua gracilis)*	14	2-33	100
NORTHERN WHEATGRASS *(Agropyron dasystachyum)*	5	0-15	87
JUNE GRASS *(Koeleria macrantha)*	3	0-9	96
SAND GRASS *(Calamovilfa longifolia)*	3	0-17	30
PLAINS REED GRASS *(Calamagrostis montanensis)*	2	0-11	57
WESTERN WHEAT GRASS *(Agropyron smithii)*	2	0-10	48
UNDIFFERENTIATED SEDGE *(Carex)*	2	0-10	74
SANDBERG BLUEGRASS *(Poa sandbergii)*	1	0-6	39

ENVIRONMENTAL VARIABLES

RANGE SITE:
- LOAMY
- THIN BREAKS

SOILS:
- ORTHIC BROWN (PINHORN, MASINASIN, BINGVILLE)
- ORTHIC REGOSOLIC (ORION)

ELEVATION (M):
- 920 (848-991)

SOIL DRAINAGE:
- RAPIDLY DRAINED
- MODERATELY WELL DRAINED
- WELL DRAINED

SLOPE :
- VERY GENTLE, MODERATE
- STRONG, NEARLY LEVEL, GENTLE

ASPECT:
- VARIABLE

FORAGE PRODUCTION (LB/AC)

Grass	1149 (591-1789)
Forb	132 (14-389)
Shrub	Not Available
Total	1281
Litter	1233 (672-1957)

Ecologically Sustainable Stocking Rate
0.25 AUM/ac

Blue Grama Grass - Needle and Thread DMGA10

(Bouteloua gracilis - Stipa comata) Herbaceous

n=8 This is a mid-seral plant community on loamy range sites in the Dry Mixed grass on productive mid to lower slope locations and on north facing slopes where growing conditions may be slightly moister. This community is the product of moderate-heavy to heavy grazing pressure that has resulted in a major reduction in wheatgrass cover. Increased soil exposure and reduced litter cover will coincide with changes in the plant community. When this plant community has an extensive/continuous distribution on the landscape, it signals the need for reduced stocking and improved range management practices. Wildlife managers may wish to see this community as a scattered/patchy distribution in conjunction with communities like DMGA2, thus providing greater structural diversity for species like breeding birds.

Soil Exposure: 15% (1-31) **Moss/Lichen Cover:** 2 % (0-13) **Total Litter:** 5 % (3-14%)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
FORBS			
PASTURE SAGEWORT *(Artemisia frigida)*	1	0-4	63
WINTER-FAT *(Eurotia lanata)*	1	0-4	75
PRICKLY PEAR CACTUS *(Opuntia polyacantha)*	2	0-15	25
GRASSES			
BLUE GRAMA GRASS *(Boutelua gracilis)*	20	7-60	100
NEEDLE-AND-THREAD *(Stipa comata)*	4	2-10	100
THREAD-LEAVED SEDGE *(Carex filifolia)*	3	0-24	25
SANDBERG BLUEGRASS *(Poa sandbergii)*	3	0-7	100
UNDIFFERENTIATED SEDGE *(Carex)*	3	0-7	88
WESTERN WHEAT GRASS *(Agropyron smithii)*	3	0-8	63
UNDIFFERENTIATED WHEATGRASS *(Agropyron)*	1	0-4	50
JUNE GRASS *(Koeleria macrantha)*	1	0-3	88

ENVIRONMENTAL VARIABLES

RANGE SITE:
LOAMY

SOILS:
ORTHIC BROWN (COMREY,PINHORN)

ELEVATION (M):
938 (863-975)

SOIL DRAINAGE:
WELL DRAINED
MODERATELY WELL DRAINED

SLOPE :
VERY GENTLE
NEARLY LEVEL
MODERATE

ASPECT:
NORTHERLY

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.15 AUM/ac

Silver Sagebrush/Needle and Thread - Blue Grama Grass DMGA12

(Artemisia cana/Stipa comata - Bouteloua gracilis) Herbaceous

n=152 This is the reference plant community on loamy range sites with well drained brown chernozemic soils and moderately well drained Solonetzic Brown Chernozems. The plant community is closely linked to DMGA3 and the Stipa-Bouteloua faciation described by Coupland (1961). A smaller subsample of this type was described earlier by Adams et al (2004a) for the Sage-Grouse area south of the Cypress Hills and represents the loamy end of the soil development sequence where solonetzic soils predominate. Heavy grazing pressure will reduce the cover of wheatgrass species, then needle-and-thread grass and eventually replace them with more grazing resistant speceis like blue grama, Sandberg bluegrass and sedges. Of all the loamy plant communties, this type has the highest cover of silver sagebrush at about 2% canopy cover. Forage production data presented below is 12 year average from the Murray Lake rangeland reference area located on Maleb soil series: Orthic Brown Chernozems.

Soil Exposure: 13% (0-43) **Moss/Lichen Cover:** 41 % (0-94) **Total Vegetation:** 62% (46-96%)

Plant Composition Canopy Cover(%)

	Mean	Range	Const
Forbs			
Silver Sagebrush *(Artemisia cana)*	2	0-12	70
Forbs			
Pasture Sagewort *(Artemisia frigida)*	5	0-26	80
Moss Phlox *(Phlox hoodii)*	1	0-17	55
Scarlet Mallow *(Sphaeralcea coccinea)*	1	0-11	70
Grasses			
Needle-and-Thread *(Stipa comata)*	37	0-77	100
Blue Grama Grass *(Boutelua gracilis)*	15	0-66	99
June Grass *(Koeleria macrantha)*	10	0-29	97
Northern Wheatgrass *(Agropyron dasystachyum)*	5	0-28	79
Western Wheat Grass *(Agropyron smithii)*	3	0-31	42
Sandberg Bluegrass *(Poa sandbergii)*	3	0-10	72
Plains Reed Grass *(Calamagrostis montanensis)*	2	0-24	59
Undifferentiated Sedge *(Carex)*	2	0-16	87

Environmental Variables

Range Site:
Loamy

Soils:
Orthic Brown (Bunton, Cranford, Chin, Maleb, Masinisin)
Solonetzic Brown (chinz, Tilley)

Elevation (m):
928 (822-950)

Soil Drainage:
Well drained
Moderately well drained

Slope :
Very gentle
Moderate, Nearly level
Gentle, Level

Aspect:
Southerly
Easterly

Forage Production (lb/ac)

Grass	511 (43-992)
Forb	40 (3-118)
Total	551
Litter	265 (152-336)

Ecologically Sustainable Stocking Rate
0.18 AUM/ac

Western Porcupine Grass - Needle and Thread - Sand Grass **DMGA13**

(Stipa curtiseta - Stipa comata) Herbaceous Shrub

n=16 This is a later seral to reference plant community on sandy range sites in the Dry Mixedgrass. This community is found on moderately coarse, sandy loam textured soils. Sandy range sites can be reasonably productive given their capacity for deep root penetration for good internal drainage and water infiltration. The high canopy cover of western porcupine grass is likely an expression of this. But with heavy grazing pressure and reduced vigor in the root zone, these soils will also be drought prone. This type has a significant component of sandgrass compared to DMGA14. Scurf pea *(Psoralea lanceolata)* may also occur as an indicator of the sandy soil texture. This type has been observed in the Wildhorse, Oyen and Foremost Plains and the Rainy Hills Upland.

Soil Exposure: 6 % (1-22) **Moss/Lichen Cover:** 35% (1-21) **Total Vegetation:** 82% (62-96)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
SHRUBS			
SILVER SAGEBRUSH			
(Artemisia cana)	1	0-9	6
FORBS			
SCARLET MALLOW			
(Sphaeralcea coccinea)	1	0-6 5	6
PASTURE SAGEWORT			
(Artemisia frigida)	1	0-4	69
GRASSES			
WESTERN PORCUPINE GRASS			
(Stipa curtiseta)	25	8-45	100
NEEDLE-AND-THREAD			
(Stipa comata)	20	2-40	100
JUNE GRASS			
(Koeleria macrantha)	7	1-24	100
BLUE GRAMA GRASS			
(Bouteloua gracilis)	7	0-23	94
SAND GRASS			
(Calamovilfa longifolia)	6	0-29	4
WESTERN WHEAT GRASS			
(Agropyron smithii)	6	0-22	63
UNDIFFERENTIATED SEDGE			
(Carex)	5	0-27	75
PLAINS REED GRASS			
(Calamagrostis montanensis)	2	0-13	63

ENVIRONMENTAL VARIABLES

RANGE SITE:

SANDY

SOILS:

ORTHIC BROWN (BINGEVILLE, PURPLE SPRINGS, RAINIER)

ELEVATION:

SOIL DRAINAGE:

WELL DRAINED

SLOPE :

VERY GENTLE
MODERATE
GENTLE

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.23 AUM/ac

Western Wheat Grass - Needle and Thread DMGA14

(Agropyron smithii - Stipa comata) Herbaceous

n=7 This is a later seral to reference plant community on sandy range sites in the Dry Mixedgrass. This community is found on moderately coarse, sandy loam textured soils. Sandy range sites can be reasonably productive given their capacity for deep root penetration and water infiltration rates. But with heavy grazing pressure and reduced vigor in the root zone, these soils will also be drought prone. This type has been observed in the Wildhorse, Oyen and Foremost Plains and the Rainy Hills Upland.

Soil Exposure: 28 % (1-64) **Moss/Lichen Cover:** 12% (1-56) **Total Vegetation:** 68 %(48-83)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
FORBS			
BROOMWEED *(Gutierrezia sarothrae)*	6	0-19	43
PASTURE SAGEWORT *(Artemisia frigida)*	4	0-21	86
PRICKLY PEAR CACTUS *(Opuntia polyacantha)*	2	0-17	14
SCARLET MALLOW *(Sphaeralcea coccinea)*	1	0-5	29
GRASSES			
WESTERN WHEAT GRASS *(Agropyron smithii)*	40	16-66	100
NEEDLE-AND-THREAD *(Stipa comata)*	9	0-37	86
UNDIFFERENTIATED SEDGE *(Carex)*	5	1-11	100
JUNE GRASS *(Koeleria macrantha)*	5	0-23	100
BLUE GRAMA GRASS *(Bouteloua gracilis)*	3	0-8	71
CANBY BLUEGRASS *(Poa canbyi)*	2	0-10	29
GREEN NEEDLE GRASS *(Stipa viridula)*	1	0-5	29

ENVIRONMENTAL VARIABLES

RANGE SITE:
SANDY

ELEVATION (M):
767 (762-771)

SOILS: ORTHIC BROWN (BINGEVILLE, PURPLE SPRINGS, RAINIER)

SOIL DRAINAGE:
RAPIDLY DRAINED
WELL DRAINED

SLOPE :
VERY GENTLE
LEVEL, NEARLY LEVEL

ASPECT:
NORTHERLY
SOUTHERLY

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.22 AUM/ac

Wheat Grass - Needle and Thread - June Grass DMGA15

(Agropyron - Stipa comata - Koeleria macrantha) Herbaceous

n=11 This is a late seral to reference plant community for blowout range sites in the Dry Mixedgrass. This particular community occurs on soils that are in mid to latter phase of the solonetzic soil development process (centre and right of centre in the soil development sequence in Fig. 4). Solonetzic features persist, but like DMGA16 and DMGA35, internal drainage has improved. Consequently needle-and-thread grass can persist as a dominant species and the amount of soil exposure is diminished when compared to communities like DMGA17, DMGA34 and DMGA39. Silver sagebrush may occur in only trace amounts in this community type.

Soil Exposure: 13 % (1-43) **Moss/Lichen Cover:** 53 % (1-76) **Total Vegetation:** 53% (30-87%)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
SHRUBS			
SILVER SAGEBRUSH *(Artemisia cana)*	1	0-8	18
FORBS			
PASTURE SAGEWORT *(Artemisia frigida)*	11	0-27	91
SCARLET MALLOW *(Sphaeralcea coccinea)*	1	0-5	55
GRASSES			
UNDIFFERENTIATED WHEAT GRASS *(Agropyron)*	24	11-41	100
NEEDLE-AND-THREAD *(Stipa comata)*	22	6-38	100
JUNE GRASS *(Koeleria macrantha)*	14	0-23	91
UNDIFFERENTIATED SEDGE *(Carex)*	10	3-25	100
BLUE GRAMA GRASS *(Boutelua gracilis)*	4	0-16	73
SANDBERG BLUEGRASS *(Poa sandbergii)*	3	0-13	64
PLAINS REED GRASS *(Calamagrostis montanensis)*	3	0-11	64
WESTERN PORCUPINE GRASS *(Stipa curitseta)*	2	0-12	27

ENVIRONMENTAL VARIABLES

RANGE SITE:
- BLOWOUT

SOILS:
- ORTHIC BROWN (FOREMOST)
- DARK BROWN SOLODIZED SOLONETZ (WIESE)
- BROWN SOLOD (KARLSBAD, ROSEMARY, HALLIDAY)
- BROWN SOLODIZED SOLONETZ (HEMARUKA, WARDLOW, PATRICIA)

ELEVATION:
- 770-825 M

SOIL DRAINAGE:
- MODERATELY WELL DRAINED
- WELL DRAINED

SLOPE :
- VERY GENTLE
- NEARLY LEVEL

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.16 AUM/ac

Western Wheat Grass - Sedge - Needle and Thread DMGA16

(Agropyron smithii- Carex - Stipa comata) Herbaceous

n=33 This is a late seral to reference plant community for blowout range sites in the Dry Mixedgrass. This particular community occurs on soils that are in the latter phase of the solonetzic soil development process (represented by the centre and right side of the soil development sequence in Fig. 4). While minor solonetzic features may persist in the soil profile, needle-and-thread grass and moss/lichen cover are abundant and soil exposure is low. This community, along with DMGA15 and DMGA35, will be among the more productive of plant communities on blowout range sites. Silver sagebrush may occur in only trace amounts in this community type.

Soil Exposure: 10 % (1-30) **Moss/Lichen Cover:** 49 % (1-90) **Total Vegetation:** 69% (50-93%)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
FORBS			
PASTURE SAGEWORT *(Artemisia frigida)*	7	0-28	97
SCARLET MALLOW *(Sphaeralcea coccinea)*	3	0-13	79
GRASSES			
WESTERN WHEAT GRASS *(Agropyron smithii)*	34	12-58	100
UNDIFFERENTIATED SEDGE *(Carex)*	12	1-29	100
NEEDLE-AND-THREAD *(Stipa comata)*	10	0-23	97
BLUE GRAMA GRASS *(Boutelua gracilis)*	9	0-36	97
JUNE GRASS *(Koeleria macrantha)*	8	0-40	91
NORTHERN WHEAT GRASS *(Agropyron dasystachyum)*	4	0-21	55
UNDIFFERENTIATED BLUEGRASS *(Poa spp.)*	1	0-14	36
SALT GRASS *(Distichlis stricta)*	1	0-9	33
SANDBERG BLUEGRASS *(Poa sandbergii)*	1	0-11	36
PLAINS REED GRASS *(Calamagrostis montanensis)*	1	0-9	30

ENVIRONMENTAL VARIABLES

RANGE SITE:
BLOWOUT

ELEVATION (M):
770

SOILS: BROWN SOLODIZED SOLONETZ (HEMARUKA, WARDLOW, PATRICIA)
BROWN SOLOD (KARLSBAD, ROSEMARY, HALLIDAY)

SOIL DRAINAGE:
MODERATELY WELL DRAINED
WELL DRAINED, POORLY DRAINED

SLOPE :
VERY GENTLE
NEARLY LEVEL, LEVEL

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.15 AUM/ac

Needle and Thread - Sandberg Bluegrass DMGA17

(Stipa comata - Poa sandbergii) Herbaceous

n=59 This community type is the late seral to reference plant community on blowout range sites in the Dry Mixedgrass. This community type represents those soils that appear to the right of centre in Fig. 4, including brown solods and solonetzic browns. In these soils, internal drainage has improved and the hard pan component of solonetzic soil is breaking down. Consequently, there is more needle-and-thread grass in the stand and a lower amount of naturally exposed soil. Silver sagebrush has a lower frequency and cover of occurrence on this type in contrast to other blowout types like DMGA34 and DMGA39. Conservative stocking rates are recommended for this type given the especially dry growing conditions imposed by the hardpan character of the surface soil.

Soil Exposure: 11% (1-61) **Moss/Lichen Cover:** 42 % (1-84) **Total Vegetation:** 53% (36-86%)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
SHRUBS			
SILVER SAGEBRUSH *(Artemisia cana)*	1	0-8	29
FORBS			
PASTURE SAGEWORT *(Artemisia frigida)*	7	0-20	98
MOSS PHLOX *(Phlox hoodii)*	2	0-7	80
NUTTALL'S ATRIPLEX *(Atriplex nuttallii)*	1	0-9	42
SCARLET MALLOW *(Sphaeralcea coccinea)*	1	0-3	76
GRASSES			
NEEDLE-AND-THREAD *(Stipa comata)*	25	10-59	100
SANDBERG BLUEGRASS *(Poa sandbergii)*	18	8-36	100
JUNE GRASS *(Koeleria macrantha)*	15	1-31	100
BLUE GRAMA GRASS *(Boutelua gracilis)*	14	4-34	100
WESTERN WHEAT GRASS *(Agropyron smithii)*	7	0-47	76
UNDIFFERENTIATED SEDGE *(Carex)*	3	0-7	95
NORTHERN WHEATGRASS *(Agropyron dasystachyum)*	1	0-13	39

ENVIRONMENTAL VARIABLES

RANGE SITE:
BLOWOUT
SOILS:
BROWN SOLOD (HALLIDAY, GEM)
SOLONETZIC BROWN (RONALAINE)

ELEVATION (M):
983 (865-1047)

SOIL DRAINAGE:
WELL DRAINED
MODERATELY WELL
SLOPE :
VERY GENTLE
NEARLY LEVEL, GENTLE
ASPECT:
SOUTHERLY
NORTHERLY

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.14 AUM/ac

Silver Sagebrush / Needle and Thread - Blue Grama Grass - June Grass
DMGA18

(Artemisia cana / Stipa comata - Bouteloua gracilis - Koeleria macrantha) Herbaceous Shrub

n=170 This is a major reference plant community for sands and sandy range sites in the Dry Mixedgrass. This is found on a wide range of sandy loam to loamy sand textured soils in the natural subregion on mostly sand plain and undulating topography and occurs most commonly on Antonio, Bingville and Cavendish soil series. This community type represents the most stable of plant communities in the Sands range site sequence and are very similar to loamy - Needle and Thread-Blue Grama communities in terms of species composition and structure. Indicator species that reveal the coarse soil texture include sand grass and scurf pea. Silver sagebrush appears to do well on this range site presumably due to the internal drainage and easy rooting conditions.

Soil Exposure: 22% (1-62) **Moss/Lichen Cover:** 20% (0-77) **Total Vegetation:** 67% (21-89)

Plant Composition Canopy Cover(%)

	Mean	Range	Const
Shrubs			
Silver Sagebrush *(Artemisia cana)*	2	0-33	45
Forbs			
Pasture Sagewort *(Artemisia frigida)*	5	0-76	78
Prickly Pear Cactus *(Opuntia polyacantha)*	2	0-19	38
Scarlet Mallow *(Sphaeralcea coccinea)*	1	0-10	28
Grasses			
Needle-and-Thread *(Stipa comata)*	39	3-77	100
Blue Grama Grass *(Bouteloua gracilis)*	14	0-49	96
June Grass *(Koeleria macrantha)*	8	0-37	92
Undifferentiated Sedge *(Carex)*	6	0-29	90
Western Wheat Grass *(Agropyron smithii)*	3	0-27	55
Sand Grass *(Calamovilfa longifolia)*	1	0-10	32
Northern Wheat Grass *(Agropyron dasystachyum)*	1	0-21	42

Environmental Variables

Range Site:
Sandy, Sands
Choppy Sandhills

Elevation (m):
764 (728-846)

Soils: Orthic Brown (antonio, cavendish, bingeville, ramillies, maleb cranford)
Orthic Dark Brown (kessler)

Soil Drainage:
rapidly Drained
Well Drained
Very rapidly Drained

Slope :
Very Gentle,Nearly Level
Gentle

Aspect:
Northerly, Southerly

Forage Production (lb/ac)

Grass	Not Available
Forb	Not Available
Shrub	Not Available
Litter	Not Available
Total	Not Available

Ecologically Sustainable Stocking Rate
0.17 AUM/ac

Silver Sagebrush / Needle and Thread - Sand Grass DMGA19

(Artemisia cana / Stipa comata - Calamovilfa longifolia) Herbaceous Shrub

n=54 This is a late seral plant community on sands range sites in the Dry Mixedgrass. This type is successional stage to DMGA43 and the high proportion of sand grass is likely due to greater disturbance history. Soil textures are predominantly very coarse to moderately coarse textured sand on level to moderately sloping topography. Indicator species of the coarse textured soil include shrub species, scurf pea, sand grass and sand dropseed, that are more frequent and abundant in this community type than in DMGA18.

Soil Exposure: 21% (1-45) **Moss/Lichen Cover:** 7 % (1-62) **Total Vegetation:** 74% (55-93)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
SHRUBS			
SILVER SAGEBRUSH *(Artemisia cana)*	3	0-21	44
FORBS			
PRICKLY PEAR CACTUS *(Opuntia polyacantha)*	4	0-18	54
PASTURE SAGEWORT *(Artemisia frigida)*	3	0-13	91
GOLDEN ASTER *(Heterotheca villosa)*	1	0-8	41
GRASSES			
NEEDLE-AND-THREAD *(Stipa comata)*	29	11-59	100
SAND GRASS *(Calamovilfa longifolia)*	21	10-60	100
BLUE GRAMA GRASS *(Bouteloua gracilis)*	9	0-28	98
JUNE GRASS *(Koeleria macrantha)*	5	0-20	93
UNDIFFERENTIATED SEDGE *(Carex)*	4	0-22	91
WESTERN WHEAT GRASS *(Agropyron smithii)*	2	0-14	63
NORTHERN WHEAT GRASS *(Agropyron dasystachyum)*	1	0-9	46

ENVIRONMENTAL VARIABLES

RANGE SITE:
- SANDS
- SANDY
- CHOPPY SANDHILLS

ELEVATION (M):
767 (762-770)

SOILS: ORTHIC BROWN (CAVENDISH, BINGEVILLE, CHIN, RAMILLIES)
ORTHIC REGOSOL (ANTELOPE)

SOIL DRAINAGE:
- RAPIDLY DRAINED
- VERY RAPIDLY DRAINED
- WELL DRAINED

SLOPE :
- VERY GENTLE
- NEARLY LEVEL
- GENTLE

ASPECT:
NORTHERLY, SOUTHERLY

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.15 AUM/ac

Silver Sagebrush/ Undifferentiated Wheatgrass - DMGA20

(Artemisia cana / Agropyron spp.)Herbaceous shrub

n=4 The Silver Sagebrush/ Undifferentiated Wheatgrass type is a late seral to PNC community type associated with saline lowland range sites in the Dry Mixedgrass. This community is found in depressional areas and level plains with periodic ponding of water and slightly lower salinity than the Silver Sagebrush/Undifferentiated Wheatgrass type. Drainage is generally imperfect with textures ranging from silt loam to silty clay. Productivity data are not available, but this type will likely yield significantly more herbage than the previous type given the increase in wheatgrass density and cover. Litter residue is estimated at 277 lb/ac. This type is correlated with slightly better developed soils (alkaline solonetz, lower salinity and weak development of columnar structure) compared to the Silver sagebrush/ Undifferentiated Wheatgrass - Nuttaill's Atriplex type and also has significantly more vegetative cover and less soil exposure. This type may be less attractive as a strutting site for Sage-Grouse courtship activities given greater vegetation ground cover. Silver sagebrush has a dwarfed growth habit on this type as well.

Soil Exposure: 39%(31-49) **Moss/Lichen Cover:** 21%(12-32) **Total Vegetation:** 57%(42-83)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
SHRUBS			
SILVER SAGEBRUSH *(Artemisia cana)*	2	0-7	50
FORBS			
NUTTALL'S ATRIPLEX *(Atriplex nutallii)*	1	0-5	50
FRINGED SAGEWORT *(Artemisia frigida)*	3	0-12	50
GRASSES			
NORTHERN WHEATGRASS *(Agropyron dasystachyum)*	4	0-10	75
WESTERN WHEATGRASS *(Agropyron smithii)*	4	0-11	75
BLUE GRAMA GRASS *(Bouteloua gracilis)*	3	0-12	50
SALT GRASS *(Distichlis stricta)*	4	0-15	25
ALKALI GRASS *(Puccinellia spp.)*	3	0-13	25
UNDIFFERENTIATED SEDGE *(Carex spp.)*	2	0-5	25
BLUEGRASS *(Poa spp.)*	2	0-6	25
JUNE GRASS *(Koeleria macrantha)*	1	0-2	75
SANDBERG'S BLUE GRASS *(Poa sandbergii)*	0	0-2	75

ENVIRONMENTAL VARIABLES

RANGE SITE
SALINE LOWLAND

SOILS
ORTHIC REGOSOL (ORION)
ALKALINE SOLONETZ(BULLPOUND)

ELEVATION:
850-975 M

SOIL DRAINAGE:
WELL DRAINED
MODERATELY WELL DRAINED
IMPERFECTLY DRAINED

SLOPE :
LEVEL DEPRESSION

ASPECT:
LEVEL

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	277 (30-700)
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.15 AUM/ac

Silver Sagebrush/Wheatgrass - Nuttall's DMGA21

(Artemisia cana/Agropyron spp. - Atriplex nuttallii) Shrub herbaceous

n=8 The Silver Sagebrush/Wheatgrass - Nuttall's Atriplex community type (shrub/herbaceous) is a late seral to PNC community type associated with saline lowlands in the Dry Mixedgrass. This community is found in depressional areas and level plains with periodic ponding of water and high sodicity. Soils are poorly developed Saline Regosols or Alkaline Solonetz, developed on fluvial and lacustrine parent materials. Drainage is generally imperfect to moderately well drained with textures ranging from silt loam to silty clay. Productivity data are not available for this type but average total annual yield of grasses and forbs would likely be less than 100 lb/ac. Based on one years data (2001) litter residue is estimated at 158 lb/ac. As soils continue to develop from a Saline Regosol to Alkaline Solonetz (expressed as slightly better soil drainage and the appearance of weak columnar structure) plant succession will proceed to the Silver Sagebrush/Wheatgrass (Saline lowland) type which has significantly more vegetative cover and less soil exposure. Saline lowlands are commonly used as strutting grounds where Sage-Grouse courtship and breeding activities occur - given the barren site characteristics and lack of plant community structure. Silver sagebrush takes on a dwarfed stature on this type averaging only .1 m in height.

Soil Exposure: 75 % (60-90) **Moss/Lichen Cover:** 4 % (.2 - 11) **Total Vegetation:** 26% (13 - 38%)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
SHRUBS			
SILVER SAGEBRUSH			
(*Artemisia cana*)	4	1-10	75
FORBS			
NUTTALL'S ATRIPLEX			
(Atriplex nutallii)	2	1-6	75
FRINGED SAGEWORT			
(Artemisia frigida)	1	0-3	67
GRASSES			
NORTHERN WHEATGRASS			
(Agropyron dasystachyum)	2	0-10	88
WESTERN WHEATGRASS			
(Agropyron smithii)	2	0-11	63
BLUE GRAMA GRASS			
(Bouteloua gracilis)	3	0-12	50
UNDIFFERENTIATED SEDGE			
(Carex)	2	0-5	50
SANDBERG BLUEGRASS			
(Poa sandbergii)	1	0-3	100
JUNE GRASS			
(Koeleria macrantha)	1	0-3	67
NEEDLE ANDTHREAD			
(Stipa comata)	1	0-5	67

ENVIRONMENTAL VARIABLES

RANGE SITE

SALINE LOWLAND

SOILS

SALINE ORTHIC REGOSOL (SCOTFIELD, WESTON-AA)

ELEVATION:

850-975 M

SOIL DRAINAGE:

IMPERFECTLY TO MODERATELY WELL

SLOPE :

LEVEL AND DEPRESSIONAL

ASPECT:

N/A

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	158 (50-350)
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.05 AUM/ac

Needle and Thread - Blue Grama Grass - June Grass DMGA22

(Stipa comata - Bouteloua gracilis - Koeleria macrantha) Herbaceous

n=20 This is a reference plant community for thin breaks range sites in the Dry Mixedgrass. Thin breaks range sites are all steeply sloping landscapes with less than 10% bedrock exposures and generally with bedrock at or near the surface (Badlands range sites have >10% bedrock exposures). Site conditions make for a higher percentage of natural bare soil.

Soil Exposure: 22 % (1-53) **Moss/Lichen Cover:** 32 % (1-88) **Total Vegetation:** 62% (42-91)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
SHRUBS			
SILVER SAGEBRUSH *(Artemisia cana)*	1	0-7	20
FORBS			
PASTURE SAGEWORT *(Artemisia frigida)*	6	0-41	75
MOSS PHLOX *(Phlox hoodii)*	1	0-6	40
SCARELT MALLOW *(Sphaeralcea coccinea)*	1	0-3	70
GRASSES			
NEEDLE-AND-THREAD *(Stipa comata)*	42	13-69	100
BLUE GRAMA GRASS *(Boutelua gracilis)*	14	3-33	100
JUNE GRASS *(Koeleria macrantha)*	8	1-27	100
UNDIFFERENTIATED SEDGE *(Carex)*	6	0-40	85
THREAD-LEAVED SEDGE *(Carex filifolia)*	5	0-29	40
SANDBERG BLUEGRASS *(Poa sandbergii)*	3	0-20	55
NORTHERN WHEAT GRASS *(Agropyron dasystachyum)*	2	0-10	45
WESTERN WHEAT GRASS *(Agropyron smithii)*	2	0-13	50

ENVIRONMENTAL VARIABLES

RANGE SITE:
THIN BREAKS

ELEVATION (M):
896 (848-921)

SOILS: ORTHIC BROWN (COMREY, PINHORN)
ORTHIC REGOSOL

SOIL DRAINAGE:
RAPIDLY DRAINED
WELL DRAINED

SLOPE :
STRONG
STEEP

ASPECT:
SOUTHERLY
EASTERLY, NORTHERLY

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.1 AUM/ac

Silver Sagebrush/Needle and Thread - Blue Grama Grass - June Grass

DMGA23

(Artemisia cana / Stipa comata - Bouteloua gracilis - Koeleria macrantha) Herbaceous

n=21 This is a reference plant community for gravel and shallow to gravel range sites in the Dry Mixedgrass. While the plant community closely resembles DMGA3 in species composition, productivity is much lower due to the presence of gravel parent materials at or near the surface. Gravel range sites have less than 20 cm of topsoil over very gravelly or very cobbly parent material (>50% gravels or cobbles). Shallow to gravel range sites may have 20 to 50 cm of topsoil over gravel(>20% gravel or cobbles). Soil moisture levels limit the productivity of this plant community and this type is easily damaged by overstocking. Appropriate adjustments need to be made in setting a sustainable stocking rate for this type. ESSR values are provided in the preceding stocking rate tables. (The data for this community is reported in duplicate as DMGA37 until further analysis can separate vegetation plots more accurately between gravel and shallow to gravel range sites).

Soil Exposure: 12 % (1-36) **Moss/Lichen Cover:** 15 % (1-47) **Total Vegetation:** 69% (62-78)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
FORBS			
SILVER SAGEBRUSH *(Artemisia cana)*	3	0-9	76
FORBS			
SCARLET MALLOW *(Sphaeralcea coccinea)*	4	0-21	67
PASTURE SAGEWORT *(Artemisia frigida)*	3	0-9	95
GOLDEN BEAN *(Thermopsis rhombifolia)*	2	0-7	57
MOSS PHLOX *(Phlox hoodii)*	1	0-6	57
SCARLET BUTTERFLYWEED *(Gaura coccinea)*	1	0-6	38
GRASSES			
NEEDLE-AND-THREAD *(Stipa comata)*	26	5-57	100
BLUE GRAMA GRASS *(Boutelua gracilis)*	21	4-46	100
JUNE GRASS *(Koeleria macrantha)*	11	1-24	100
UNDIFFERENTIATED SEDGE *(Carex)*	4	1-9	100
NORTHERN WHEAT GRASS *(Agropyron dasystachyum)*	1	0-8	52

ENVIRONMENTAL VARIABLES

RANGE SITE:
GRAVEL
SHALLOW-TO-GRAVEL

ELEVATION (M):
762 (739-770)

SOILS: ORTHIC BROWN (KANGAROO, PEMUKAN)
ORTHIC REGOSOL (ETZIKOM)

SOIL DRAINAGE:
VERY RAPIDLY DRAINED
RAPIDLY DRAINED
WELL DRAINED

SLOPE :
NEARLY LEVEL
VERY GENTLE
GENTLE

ASPECT:
VARIABLE

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.15 AUM/ac

Silver Sagebrush / Needle and Thread - Western Wheat Grass - Blue Grama Grass DMGA24

(Artemisia cana / Stipa comata - Agropyron smithii - Bouteloua gracilis) Herbaceous

n=4 This is the reference plant community for limy range sites in the Dry Mixedgrass. Limy range sites have immature and eroded profiles with free lime (calcium carbonates) at the soil surface or in the B horizon. This can be detected by checking for effervescence with 10% HCL. While species composition resembles plant communities like DMGA2 and DMGA3, the community tends to less productive and stocking rates needs to be set lower than for loamy sites.

Soil Exposure: 13 % (4-22) **Moss/Lichen Cover:** 34 % (1-74) **Total Vegetation:** 68% (48-83)

PLANT COMPOSITION CANOPY COVER(%)

	Mean	Range	Const
Shrubs			
Silver Sagebrush *(Artemisia cana)*	8	0-17	50
Forbs			
Pursh's Plantain *(Plantago patagonica)*	4	0-13	50
Pasture Sagewort *(Artemisia frigida)*	3	0-8	50
Prickly Pear Cactus *(Opuntia polyacantha)*	3	0-5	50
Scarlet Mallow *(Sphaeralcea coccinea)*	2	0-8	50
Grasses			
Needle-and-Thread *(Stipa comata)*	36	32-41	100
Western Wheat Grass *(Agropyron smithii)*	13	10-17	100
Blue Grama Grass *(Boutelua gracilis)*	13	11-16	100
Northern Wheat Grass *(Agropyron dasystachyum)*	5	2-9	100
June Grass *(Koeleria macrantha)*	5	2-7	100
Undifferentiated Sedge *(Carex)*	1	0-2	75

ENVIRONMENTAL VARIABLES

Range Site:
Limy

Elevation (m):
918

Soils: Calcareous Brown (Expanse)
Regosolic Brown (Helmsdale)

Soil Drainage:
Well drained

Slope :
Very Gentle

Aspect:
Northerly
Southerly

FORAGE PRODUCTION (LB/AC)

Grass	Not Available
Forb	Not Available
Shrub	Not Available
Litter	Not Available
Total	Not Available

Ecologically Sustainable Stocking Rate
0.18 AUM/ac

Sandberg Bluegrass - Northern Wheat Grass DMGA30

(Poa sandbergii - Agropyron dasystachyum) Herbaceous

n=3 This community type is a mid-seral plant community on moderately well drained to imperfectly drained solonetzic soils in the Dry Mixedgrass. The blowout type in question is representative of the solonetzic soils in Fig. 4 that occur to the left of centre in the image, including brown solonetz and brown solodized solonetz. The higher proportion of Sandberg's bluegrass in relation to the reference plant community for this type (DMGA39) is likely due to past heavy grazing pressure. Silver sagebrush, if present, occurs at low levels of canopy cover. Conservative stocking rates are recommended for this type to foster range recovery, and because of the especially dry growing conditions imposed by the hardpan character of the surface soil.

Soil Exposure: 38% (13-57) **Moss/Lichen Cover:** 27 % (1-77) **Total Vegetation:** 56% (47-63%)

Plant Composition Canopy Cover(%)

	Mean	Range	Const
Forbs			
Pasture Sagewort *(Artemisia frigida)*	11	8-15	100
Winter-fat *(Eurotia lanata)*	9	0-27	33
Moss Phlox *(Phlox hoodii)*	1	0-4	33
Grasses			
Sandberg Bluegrass *(Poa sandbergii)*	28	22-39	100
Northern Wheatgrass *(Agropyron dasystachyum)*	23	9-40	100
June Grass *(Koeleria macrantha)*	15	0-31	67
Low Sedge *(Carex stenophylla)*	4	0-13	33
western Wheat Grass *(Agropyron smithii)*	2	0-5	33
Undifferentiated Sedge *(Carex)*	2	0-3	67
Blue Grama Grass *(Boutelua gracilis)*	1	0-3	33

Environmental Variables

Range Site:
Blowout

Soils:
Brown Solodized Solonetz
(Steveville, Hemaruka)

Soil Drainage:
Imperfectly drained
Moderately well drained

Slope :
Nearly level
Very gentle
level

Forage Production (lb/ac)

Grass	Not Available
Forb	Not Available
Shrub	Not Available
Litter	Not Available
Total	Not Available

Ecologically Sustainable Stocking Rate
0.08 AUM/ac

Silver Sagebrush / Sandberg Bluegrass - June Grass DMGA31

(Artemisia cana / Poa sandbergii - Koeleria macrantha) Herbaceous

n=7 This is a mid seral plant community on blowout range sites in the Dry Mixedgrass on moderately well drained to imperfectly drained solonetzic soils of loam to clay loam texture, termed blowout range sites with characteristic eroded pits in the soil surface. This community is a seral stage of MGA34. Heavy grazing pressure reduces the cover of northern and western wheatgrass which is replaced by Sandberg's bluegrass. Extra rest and conservative stocking rates are required to reverse the decline in range health that this community represents.

Soil Exposure: 15 % (2-46) **Moss/Lichen Cover:** 42 % (21-55) **Total Vegetation:** 50% (38-60)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
SHRUBS			
SILVER SAGEBRUSH *(Artemisia cana)*	4	0-10	71
FORBS			
PASTURE SAGEWORT *(Artemisia frigida)*	7	2-11	100
PRICKLY PEAR CACTUS *(Opuntia polyacantha)*	2	0-8	29
CREEPING WHITE PRAIRIE ASTER *(Aster falcatus)*	1	0-6	43
SCARLET MALLOW *(Sphaeralcea coccinea)*	1	0-2	71
GRASSES			
SANDBERG BLUEGRASS *(Poa sandbergii)*	29	19-50	100
JUNE GRASS *(Koeleria macrantha)*	18	10-24	100
WESTERN WHEAT GRASS *(Agropyron smithii)*	13	3-24	100
BLUE GRAMA GRASS *(Boutelua gracilis)*	10	0-18	86
NEEDLE-AND-THREAD *(Stipa comata)*	4	0-8	86
UNDIFFERENTIATED SEDGE *(Carex)*	3	1-4	100
PLAINS MUHLY *(Muhlenbergia cuspidata)*	1	0-3	43

ENVIRONMENTAL VARIABLES

RANGE SITE:
BLOWOUT

SOILS:
BROWN SOLODIZED SOLONETZ
(WARDLOW, STEVEVILLE)

ELEVATION (M):
1017 (1000-1031)

SOIL DRAINAGE:
MODERATELY WELL
IMPERFECTLY

SLOPE :
NEARLY LEVEL
VERY GENTLE
GENTLE

ASPECT:
SOUTHERLY
NORTHERLY

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.06 AUM/ac

Needle and Thread - Wild Licorice DMGA32

(Stipa comata - Glycyrrhiza lepidota) Herbaceous

n=4 This is a mid seral patch type in sands, choppy sandhills and sandy range sites in the Dry Mixedgrass. This community type is based on vegetation transects adjoining livestock watering facilities like dugouts or troughs. The presence of wild licorice indicates the presence of enhanced subsoil moisture conditions. Grazing pressure associated with the community type is moderate to heavy given the attraction livestock have to the water source. The community is rich in grazing resistant Subsurface moisture appears to mitigate the development of base soil and wild licorice appears to respond as an increaser species on the site.

Soil Exposure: 8 % (8-8) **Moss/Lichen Cover:** 1 % (1-1) **Total Vegetation:** 54% (45-62)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
FORBS			
PASTURE SAGEWORT *(Artemisia frigida)*	7	0-16	50
GOLDEN BEAN *(Thermopsis rhombifolia)*	3	0-6	50
WESTERN YARROW *(Achillea millefolium)*	2	1-2	100
HAREBELL *(Campanula rotundifolia)*	1	0-2	100
GRASSES			
NEEDLE-AND-THREAD *(Stipa comata)*	21	8-33	100
WILD LICORICE *(Glycyrrhiza lepidota)*	21	15-27	100
WIRE RUSH *(Juncus balticus)*	6	0-12	100
WESTERN WHEAT GRASS *(Agropyron smithii)*	5	4-9	100
SALT GRASS *(Distichlis stricta)*	5	0-12	50
JUNE GRASS *(Koeleria macrantha)*	3	2-4	100
UNDIFFERENTIATED SEDGE *(Carex)*	2	1-3	100
CANBY BLUEGRASS *(Poa canbyi)*	2	0-5	50
BLUE GRAMA GRASS *(Bouteloua gracilis)*	1	1-1	100

ENVIRONMENTAL VARIABLES

RANGE SITE:
CHOPPY SANDHILLS
SANDY

ELEVATION (M):
770

SOILS: ORTHIC BROWN (BINGEVILLE, CAVENDISH)

SOIL DRAINAGE:
VERY RAPIDLY DRAINED

SLOPE :
NEARLY LEVEL

ASPECT:
SOUTHERLY

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.15 AUM/ac

Needle and Thread - Pasture Sagewort DMGA33

(Stipa comata - Artemisia frigida) Herbaceous

n=6 This is a late mid to late seral plant community for gravel and shallow to gravel range sites in the Dry Mixedgrass. This community is the result of moderate-heavy stocking resulting in an increase in the amount of pasture sagewort and exposed soil. Gravel range sites have less than 20 cm of topsoil over very gravelly or very cobbly parent material (>50% gravels or cobbles). Shallow to gravel range sites may have 20 to 50 cm of topsoil over gravel(>20% gravel or cobbles). Soil moisture levels limit the productivity of this plant community and this type is easily damaged by overstocking. Lighter stocking is required to reduce soil exposure and restore plant vigor. Appropriate adjustments need to be made in setting a sustainable stocking rate for this type. ESSR values are provided in the preceding stocking rate tables.

Soil Exposure: 21 % (8-37) **Moss/Lichen Cover:** 33 % (1-58) **Total Vegetation:** 61% (53-66)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
FORBS			
PASTURE SAGEWORT *(Artemisia frigida)*	20	17-28	100
SCARLET MALLOW *(Sphaeralcea coccinea)*	2	0-5	33
COMMON GOAT'S BEARD *(Tragopogon dubius)*	1	0-4	67
COMMON DANDELION *(Taraxacum officinale)*	1	0-3	67
SCARLET BUTTERFLYWEED *(Gaura coccinea)*	1	0-2	33
WILD VETCH *(Vicia americana)*	0	0-1	33
GRASSES			
NEEDLE-AND-THREAD *(Stipa comata)*	48	36-70	100
JUNE GRASS *(Koeleria macrantha)*	12	0-21	100
BLUE GRAMA GRASS *(Boutelua gracilis)*	5	0-9	67
WESTERN WHEAT GRASS *(Agropyron smithii)*	1	0-3	67
NORTHERN WHEAT GRASS *(Agropyron dasystachyum)*	1	0-3	33
UNDIFFERENTIATED SEDGE *(Carex)*	1	0-2	67
LOW SEDGE *(Carex stenophylla)*	1	0-3	33

ENVIRONMENTAL VARIABLES

RANGE SITE:
GRAVEL
SHALLOW TO GRAVEL

ELEVATION (M):
863 (754-918)

SOILS: ORTHIC BROWN (KANGAROO, PEMUKAN)
ORTHIC REGOSOL (ETZIKOM)

SOIL DRAINAGE:
WELL DRAINED
VERY RAPIDLY DRAINED

SLOPE :
NEARLY LEVEL

ASPECT:
EASTERLY
NORTHERLY

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.1 AUM/ac

Silver Sagebrush/Northern Wheat Grass - June Grass DMGA34

(Artemisia cana / Agropyron dasystachyum - Koeleria macrantha) Herbaceous

n=72 This community type is the late seral to reference plant community on moderately well drained to imperfectly drained solonetzic soils of loam to clay loam texture, termed blowout range sites with characteristic eroded pits in the soil surface. This is similar to the Bouteloua-Agropyron community described by Coupland (1950, 1961) a product of the special character of blowout conditions. Parent materials are developed from lacustrine material or glacial till, both of which may be rich in marine shales. Needle-and-thread grass, normally dominant in most Dry Mixed Grass plant communities, is not well suited to the impermeable subsoils, where northern and western wheatgrass are more successful (Weaver 1942, Coupland 1961). Silver sagebrush is normally part of this community providing an important source of structure. Productivity data summarized below is the average of 12 years at Cressday and Sage Creek rangeland reference sites. Grazing resistant species like Sandberg bluegrass will increase in abundance while canopy cover and composition of Northern and Western wheatgrass will decline. Conservative stocking rates are recommended for this type given the especially dry growing conditions imposed by the hardpan character of the surface soil.

Soil Exposure: 28% (0-56) **Moss/Lichen Cover:** 45 % (1-88) **Total Vegetation:** 56% (29-98%)

Plant Composition Canopy Cover(%)

	Mean	Range	Const
Shrubs			
Silver Sagebrush *(Artemisia cana)*	2	0-27	60
Forbs			
Pasture Sagewort *(Artemisia frigida)*	6	0-25	99
Scarlet Mallow *(Sphaeralcea coccinea)*	1	0-5	53
Grasses			
Northern Wheatgrass *(Agropyron dasystachyum)*	23	5-73	100
June Grass *(Koeleria macrantha)*	9	0-38	100
Blue Grama Grass *(Boutelua gracilis)*	6	0-30	94
Needle-and-Thread *(Stipa comata)*	5	0-11	90
Sandberg Bluegrass *(Poa sandbergii)*	4	0-35	93
Western Wheat Grass *(Agropyron smithii)*	2	0-20	57
Plains Reed Grass *(Calamagrostis montanensis)*	2	0-16	60
Undifferentiated Sedge *(Carex)*	2	0-8	83

Environmental Variables

Range Site:
Blowout

Soils:
Brown Solod (Halliday)
Brown Solodized Solonetz (Steveville, Hemaruka, Wardlow)

Elevation (m):
995 (964-1046)

Soil Drainage:
Moderately well drained
Well drained

Slope :
Nearly level
Very gentle, Level

Aspect:
Variable

Forage Production (lb/ac)

Grass	347 (187-551)
Forb	114 (27-231)
Total	461
Litter	250(100-400)

Ecologically Sustainable Stocking Rate
0.09 AUM/ac

Needle and Thread - June Grass - Blue Grama Grass DMGA35

(Stipa comata - Koeleria macrantha - Bouteloua gracilis) Herbaceous

n=84 This is a late seral to reference plant community for blowout range sites in the Dry Mixedgrass. This particular community occurs on soils that are in the latter phase of the solonetzic soil development process which are represented towards the right side of the soil development sequence in Fig. 4. While minor solonetzic features may persist in the soil profile, needle-and-thread grass and moss/lichen cover are abundant and soil exposure is low. This community, along with DMGA15 and DMGA16, will be among the more productive of plant communities on blowout range sites. Silver sagebrush may occur in only trace amounts in this community type.

Soil Exposure: 6 % (0-49) **Moss/Lichen Cover:** 46 % (3-90) **Total Vegetation:** 67% (23-96%)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
FORBS			
PASTURE SAGEWORT *(Artemisia frigida)*	4	0-24	80
SCARLET MALLOW *(Sphaeralcea coccinea)*	5	0-22	89
MOSS PHLOX *(Phlox hoodii)*	0	0-6	39
GRASSES			
NEEDLE-AND-THREAD *(Stipa comata)*	34	5-59	100
JUNE GRASS *(Koeleria macrantha)*	12	0-39	99
BLUE GRAMA GRASS *(Boutelua gracilis)*	11	0-29	100
UNDIFFERENTIATED SEDGE *(Carex)*	8	0-37	93
WESTERN WHEAT GRASS *(Agropyron smithii)*	6	0-25	73
NORTHERN WHEAT GRASS *(Agropyron dasystachyum)*	3	0-16	46
PLAINS REED GRASS *(Calamagrostis montanensis)*	1	0-10	46
SANDBERG BLUEGRASS *(Poa sandbergii)*	1	0-9	46

ENVIRONMENTAL VARIABLES

RANGE SITE:
BLOWOUT

ELEVATION (M):
773 (745-792)

SOILS:
BROWN SOLOD (HALLIDAY)
SOLONETZIC BROWN (RONALAINE, CECIL, KARLSBAD)
ORTHIC BROWN (MALEB, RANIER, FOREMOST, CAVENDISH)

SOIL DRAINAGE:
WELL DRAINED
MODERATELY WELL DRAINED

SLOPE :
VERY GENTLE
NEARLY LEVEL
ASPECT:
SOUTHERLY
NORTHERLY

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.18 AUM/ac

Blue Grama Grass - Salt Grass - Needle and Thread Grass DMGA36

(Bouteloua gracilis - Distichlis stricta-Stipa comata) Herbaceous

n=4 This is a reference plant community for badland range sites in the Dry Mixedgrass. This particular community has a relatively low soil exposure and high vegetation canopy compared to other badland types which reflects a mid to lower slope location where moisture seepage and saline discharge supports a significant cover of saltgrass. Badland range sites have greater than 10% bedrock exposure with bedrock being less than one meter from the surface.

Soil Exposure: 48 % (34-67) **Moss/Lichen Cover:** 7 % (1-16) **Total Vegetation:** 45% (38-52%)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
SHRUBS			
NUTTAL'S ATRIPLEX *(Atriplex nuttallii)*	4	0-13	50
FORBS			
PASTURE SAGEWORT *(Artemisia frigida)*	1	0-2	50
GRASSES			
BLUE GRAMA GRASS *(Boutelua gracilis)*	17	0-31	75
SALT GRASS *(Distichlis stricta)*	15	0-39	75
NEEDLE-AND-THREAD *(Stipa comata)*	9	1-28	100
UNDIFFERENTIATED SEDGE *(Carex)*	7	0-22	75
WESTERN WHEAT GRASS *(Agropyron smithii)*	7	0-23	75
UNDIFFERENTIATED BLUEGRASS *(Poa spp.)*	7	0-26	50
NORTHERN WHEAT GRASS *(Agropyron dasystachyum)*	3	0-8	50
JUNE GRASS *(Koeleria macrantha)*	3	0-5	75
SAND GRASS *(Calamovilfa longifolia)*	1	0-4	50

ENVIRONMENTAL VARIABLES

RANGE SITE:
BADLANDS

SOILS:
ORTHIC REGOSOLIC

SOIL DRAINAGE:
WELL DRAINED
RAPIDLY DRAINED

SLOPE :
STRONG

ASPECT:
VARIABLE

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.1 AUM/ac

Silver Sagebrush / Needle and Thread - Blue Grama Grass - June Grass
DMGA37
(Artemisia cana / Stipa comata - Bouteloua gracilis - Koeleria macrantha) Herbaceous

n=21 This is a reference plant community for gravel and shallow to gravel range sites in the Dry Mixedgrass. While the plant community closely resembles DMGA3 in species composition, productivity is much lower due to the presence of gravel parent materials at or near the surface. Gravel range sites have less than 20 cm of topsoil over very gravelly or very cobbly parent material (>50% gravels or cobbles). Shallow to gravel range sites may have 20 to 50 cm of topsoil over gravel(>20% gravel or cobbles). Soil moisture levels limit the productivity of this plant community and this type is easily damaged by overstocking. Appropriate adjustments need to be made in setting a sustainable stocking rate for this type. ESSR values are provided in the preceding stocking rate tables. (The data for this community is reported in duplicate as DMGA23 until further analysis can separate vegetation plots more accurately between gravel and shallow to gravel range sites).

Soil Exposure: 12 % (1-36) **Moss/Lichen Cover:** 15 % (1-47) **Total Vegetation:** 69% (62-78)

Plant Composition Canopy Cover(%)

	Mean	Range	Const
Forbs			
Silver Sagebrush *(Artemisia cana)*	3	0-9	76
Forbs			
Scarlet Mallow *(Sphaeralcea coccinea)*	4	0-21	67
Pasture Sagewort *(Artemisia frigida)*	3	0-9	95
Golden Bean *(Thermopsis rhombifolia)*	2	0-7	57
Moss Phlox *(Phlox hoodii)*	1	0-6	57
Scarlet Butterflyweed *(Gaura coccinea)*	1	0-6	38
Grasses			
Needle-and-Thread *(Stipa comata)*	26	5-57	100
Blue Grama Grass *(Boutelua gracilis)*	21	4-46	100
June Grass *(Koeleria macrantha)*	11	1-24	100
Undifferentiated Sedge *(Carex)*	4	1-9	100
Northern Wheat Grass *(Agropyron dasystachyum)*	1	0-8	52

Environmental Variables

Range Site:
Shallow-to-Gravel
Gravel

Elevation (m):
762 (739-770)

Soils: Orthic Brown (Ramillies)

Soil Drainage:
Very rapidly drained
Rapidly drained
Well drained
Slope :
Nearly Level
Very Gentle
Gentle
Aspect:
Variable

Forage Production (lb/ac)

Grass	Not Available
Forb	Not Available
Shrub	Not Available
Litter	Not Available
Total	Not Available

Ecologically Sustainable Stocking Rate
0.17 AUM/ac

Needle and Thread - Pasture Sagewort DMGA38

(Stipa comata - Artemisia frigida) Herbaceous

n=6 This is a late mid to late seral plant community for gravel and shallow to gravel range sites in the Dry Mixedgrass. This community is the result of moderate-heavy stocking resulting in an increase in the amount of pasture sagewort and exposed soil. Gravel range sites have less than 20 cm of topsoil over very gravelly or very cobbly parent material (>50% gravels or cobbles). Shallow to gravel range sites may have 20 to 50 cm of topsoil over gravel(>20% gravel or cobbles). Soil moisture levels limit the productivity of this plant community and this type is easily damaged by overstocking. Lighter stocking is required to reduce soil exposure and restore plant vigor. Appropriate adjustments need to be made in setting a sustainable stocking rate for this type. ESSR values are provided in the preceding stocking rate tables.

Soil Exposure: 21 % (8-37) **Moss/Lichen Cover:** 33 % (1-58) **Total Vegetation:** 61% (53-66)

Plant Composition Canopy Cover(%)

	Mean	Range	Const
Forbs			
Pasture Sagewort *(Artemisia frigida)*	20	17-28	100
Scarlet Mallow *(Sphaeralcea coccinea)*	2	0-5	33
Common Goat's Beard *(Tragopogon dubius)*	1	0-4	67
Common Dandelion *(Taraxacum officinale)*	1	0-3	67
Scarlet Butterflyweed *(Gaura coccinea)*	1	0-2	33
Wild Vetch *(Vicia americana)*	0	0-1	33
Grasses			
Needle-and-Thread *(Stipa comata)*	48	36-70	100
June Grass *(Koeleria macrantha)*	12	0-21	100
Blue Grama Grass *(Boutelua gracilis)*	5	0-9	67
Western Wheat grass *(Agropyron smithii)*	1	0-3	67
Northern Wheat Grass *(Agropyron dasystachyum)*	1	0-3	33
Undifferentiated Sedge *(Carex)*	1	0-2	67
Low Sedge *(Carex stenophylla)*	1	0-3	33

Environmental Variables

Range Site:
Shallow to gravel
Gravel

Elevation (m):
863 (754-918)

Soils: Orthic Brown (Ramillies)

Soil Drainage:
Well drained
Very Rapidly drained
Slope :
Nearly Level

Aspect:
Easterly
northerly

Forage Production (lb/ac)

Grass	Not Available
Forb	Not Available
Shrub	Not Available
Litter	Not Available
Total	Not Available

Ecologically Sustainable Stocking Rate
0.15 AUM/ac

Wheat Grass - Sandberg Bluegrass - DMA39

(Agropyron - Poa sandbergii) Herbaceous

n=25 This community type is the late seral to reference plant community on moderately well drained to imperfectly drained solonetzic soils termed blowout range sites with characteristic eroded pits in the soil surface. The blowout type in question is representative of the solonetzic soils in Fig. 4 that occur to the left of centre in the image, including brown solonetz and brown solodized solonetz. Soil exposure is fairly high due to the presence of eroded soil pits. The cover of needle-and-thread grass is low due to it's relative intolerance of the impermeable soil (Weaver 1942, Coupland 1961). This is similar to the Bouteloua-Agropyron community described by Coupland (1950, 1961) but with Sandberg's bluegrass as the major subdominant species. Needle-and-thread grass, normally dominant in most Dry Mixedgrass plant communities, is not well suited to the impermeable subsoils, where northern and western wheatgrass are more successful. This blowout community type has a relatively high level of soil exposure averaging 30% and silver sagebrush, if present, occurs at low levels of canopy cover. Conservative stocking rates are normally recommended for this type given the especially dry growing conditions imposed by the hardpan character of the surface soil.

Soil Exposure: 30 % (0-83) **Moss/Lichen Cover:** 15 % (0-59) **Total Vegetation/Litter:** 47% (4-91%)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
SHRUBS			
SILVER SAGEBRUSH *(Artemisia cana)*	1	0-11	20
FORBS			
PASTURE SAGEWORT *(Artemisia frigida)*	4	0-13	88
NUTTALL'S ATRIPLEX *(Atriplex nuttallii)*	1	0-11	44
PRICKLY PEAR CACTUS *(Opuntia polyacantha)*	1	0-12	24
WINTER-FAT *(Eurotia lanata)*	1	0-9	20
GRASSES			
WESTERN WHEAT GRASS *(Agropyron smithii)*	35	8-85	100
SANDBERG BLUEGRASS *(Poa sandbergii)*	10	0-26	96
JUNE GRASS *(Koeleria macrantha)*	5	0-18	80
BLUE GRAMA GRASS *(Boutelua gracilis)*	4	0-18	64
UNDIFFERENTIATED SEDGE *(Carex)*	3	0-11	80
NORTHERN WHEATGRASS *(Agropyron dasystachyum)*	3	0-18	28
NEEDLE-AND-THREAD *(Stipa comata)*	2	0-10	48

ENVIRONMENTAL VARIABLES

RANGE SITE:
BLOWOUT

SOILS:
BROWN SOLODIZED SOLONETZ
(WARDLOW, HEMARUKA, STEVEVILLE)
BROWN SOLONETZ
SOLONETZIC BROWN (RONALAINE)

ELEVATION (M):
954 (846 - 1020)

SOIL DRAINAGE:
IMPERFECTLY, MODERATELY WELL

SLOPE :
NEARLY LEVEL
VERY GENTLE, LEVEL

ASPECT:
SOUTHERLY, NORTHERLY

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.11 AUM/ac

Western Wheat Grass-Low Sedge DMGA40

(Agropyron smithii/Carex stenophylla) Herbaceous

n=20 This is a reference plant community for overflow range sites in the Suffield area, associated with the Foremost soil series in the Dry Mixedgrass. Though the Foremost soil series is classified as a loamy site, this community type occurs in micro swales and overflow positions in the landscape. In this area, green needle grass is a good indicator of overflow conditions. Given the association of the Foremost soil series with sands and sandy range sites like Cavendish and Bingville, internal drainage and rooting conditions are likely very favourable.

Soil Exposure: 8% (1-70) **Moss/Lichen Cover:** 1 % (1-6) **Total Vegetation:** 72% (4-96%)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
FORBS			
PRAIRIE SAGEWORT			
(Artemisia ludoviciana)	3	0-19	80
GOOSEFOOT			
(Chenopodium pratericola)	1	0-9	65
GREEN TANSY MUSTARD			
(Descurainia pinnata)	*1*	*0-9*	*40*
GRASSES			
WESTERN WHEATGRASS			
(Agropyron smithii)	31	5-73	95
LOW SEDGE			
(Carex stenophylla)	26	0-79	90
GREEN NEEDLE GRASS			
(Stipa viridula)	21	0-72	50
NEEDLE-AND-THREAD			
(Stipa comata)	2	0-19	20
KENTUCKY BLUEGRASS			
(Poa pratensis)	2	0-19	20

ENVIRONMENTAL VARIABLES

RANGE SITE:
OVERFLOW
SOILS:
ORTHIC BROWN (FOREMOST)

ELEVATION (M):

SOIL DRAINAGE:
MODERATELY WELL DRAINED
WELL DRAINED

SLOPE :
NEARLY LEVEL, VERY GENTLE

ASPECT:
VARIABLE

FORAGE PRODUCTION (LB/AC)

GRASS
FORB
TOTAL
LITTER

Ecologically Sustainable Stocking Rate
0.30 AUM/ac

Low Sedge -Western Wheat Grass-Green Needle Grass DMGA41

(Carex stenophylla-Agropyron smithii- Stipa viridula) Herbaceous

n=9 This is a mid to late seral plant community for overflow range sites in the Suffield area, associated with the Foremost soil series in the Dry Mixedgrass. Though the Foremost soil series is classified as a loamy site, this community type occurs in micro swales and overflow positions in the landscape. In this area, green needle grass is a good indicator of overflow conditions. Given the association of the Foremost soil series with sands and sandy range sites like Cavendish and Bingville, internal drainage and rooting conditions are likely very favourable. Soil exposure is increased over that of DMGA40, the reference plant community for the range site.

Soil Exposure: 11% (1-80) **Moss/Lichen Cover:** 1% (1-2) **Total Vegetation:** 74% (2-98%)

PLANT COMPOSITION Canopy Cover(%)

	MEAN	RANGE	CONST
FORBS			
GOOSEFOOT			
(Chenopodium pratericola)	3	0-22	56
WILD VETCH			
(Viciame americana)	1	0-6	56
GRASSES			
LOW SEDGE			
(Carex stenophylla)	41	0-87	89
WESTERN WHEATGRASS			
(Agropyron smithii)	28	0-75	89
GREEN NEEDLE GRASS			
(Stipa viridula)	12	0-56	44
BLUE GRAMA			
(Bouteloua gracilis)	4	0-20	44
NEEDLE-AND-THREAD			
(Stipa comata)	1	0-6	56

ENVIRONMENTAL VARIABLES

RANGE SITE:
OVERFLOW

SOILS:
ORTHIC BROWN (FOREMOST, CAVENDISH, PURPLE SPRINGS)

ELEVATION (M):

SOIL DRAINAGE:
MODERATELY WELL DRAINED
WELL DRAINED

SLOPE :
NEARLY LEVEL
VERY GENTLE, LEVEL

ASPECT:
VARIABLE

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
TOTAL	NOT AVAILABLE
LITTER	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.26 AUM/ac

Needle-and-Thread-Blue Grama-Low Sedge - DMGA42

(Stipa comata/Bouteloua gracilis/Carex stenophylla) Herbaceous

n=21 This is a late seral plant community for thin breaks and steep loamy/sandy range sites in the Dry Mixedgrass. This range site is associated with steep slopes in hummocky and inclined landscapes with loamy and sandy range site characteristics in the Suffield area. Soil exposure is high and total vegetation canopy cover is low. The high proportion of low sedge appears to be associated with presence of coarse textured soils. Further study will be required to confirm the reference plant community for these site conditions.

Soil Exposure: 31% (1-93) **Moss/Lichen Cover:** 2 % (1-12) **Total Vegetation:** 47% (1-93%)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
FORBS			
PRICKLY-PEAR			
(Opuntia polyacantha)	1	0-7	62
GRASSES			
NEEDLE-AND-THREAD			
(Stipa comata)	29	5-62	100
BLUE GRAMA			
(Bouteloua gracilis)	13	0-36	95
LOW SEDGE			
(Carex stenophylla)	13	0-57	95
JUNE GRASS			
(Koeleria macrantha)	5	0-25	67
WESTERN WHEATGRASS			
(Agropyron smithii)	3	0-22	48
SAND GRASS			
(Calamovilfa longifoliz)	2	0-30	24

ENVIRONMENTAL VARIABLES

RANGE SITE:
THIN BREAKS

SOILS:
ORTHIC BROWN (BUNTON, CRANFORD, FORESMOST)

ELEVATION (M):

SOIL DRAINAGE:
WELL DRAINED

SLOPE :
STRONG

ASPECT:
VARIABLE

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
TOTAL	NOT AVAILABLE
LITTER	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.1 AUM/ac

Needle and Thread-Low Sedge-Sand Grass - DMGA43

(Stipa comata-Carex stenophylla-Calamovilfa longifolia) Herbaceous Shrub

n=44 This is a late seral to reference plant community on sands range sites in the Dry Mixedgrass. This type is distinguished from DMGA18 by soil texture having predominantly very coarse to moderately coarse textured sand on level to moderately sloping topography. Indicator species of the coarse textured soil include shrub species, scurf pea, sand grass and sand dropseed, that are more frequent and abundant in this community type.

Soil Exposure: 24% (2-90) **Moss/Lichen Cover:** 4 % (1-46) **Total Vegetation:** 60% (3-89%)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
SHRUBS			
COMMON WILD ROSE *(Rosa woodsii)*	3	0-41	43
SILVER SAGEBRUSH *(Artemisia cana)*	1	0-14	25
SILVERBERRY *(Elaeagnus commutata)*	1	0-23	7
FORBS			
SCURF PEA *(Psoralea lanceolata)*	2	0-9	52
GOLDEN ASTER *(Heterotheca villosa)*	1	0-27	48
PRICKLY-PEAR *(Opuntia polyacantha)*	1	0-18	36
PASTURE SAGEWORT *(Artemisia frigida)*	1	0-6	64
GRASSES			
NEEDLE-AND-THREAD *(Stipa comata)*	30	2-70	100
LOW SEDGE *(Carex stenophylla)*	13	0-51	82
SAND GRASS *(Calamovilfa longifoliz)*	12	0-68	68
BLUE GRAMA *(Bouteloua gracilis)*	11	0-37	82
NORTHERN WHEAT GRASS *(Agropyron dasystachyum)*	4	0-30	61
JUNE GRASS *(Koeleria macrantha)*	4	0-19	59
THREAD-LEAVED SEDGE *(Carex filifolia)*	2	0-27	20
WESTERN WHEAT GRASS *(Agropyron smithii)*	2	0-24	36

ENVIRONMENTAL VARIABLES

RANGE SITE:
SANDS

SOILS:
ORTHIC BROWN (CAVENDISH)
REGO BROWN (VENDISAT)

ELEVATION (M):
750 (76-780)

SOIL DRAINAGE:
RAPIDLY DRAINED

SLOPE :
LEVEL, VERY GENTLE
MODERATE

ASPECT:
SOUTHERLY, NORTHERLY

FORAGE PRODUCTION (LB/AC)

GRASS
FORB
TOTAL
LITTER

Ecologically Sustainable Stocking Rate
0.16 AUM/ac

Salt Grass - Western Wheat Grass **DMGA44**

(Distichlis stricta - Agropyron smithii) Herbaceous

n=6 This is a mid to late seral plant community on saline lowland range sites in the Dry Mixedgrass subregion. This community appears to be a seral community to DMGA20 that is associated with Saline Lowland 2. A past disturbance history seems to be evident in this community type due to the presence of Kentucky bluegrass, common pepper-grass and foxtail barley. Soil exposure is relatively high and total vegetation can be highly variable and often low for this community type.

Soil Exposure: 31 % (2-79) **Moss/Lichen Cover:** 1 % (0-4) **Total Vegetation:** 25% (10-49)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
SHRUBS			
BUCKBRUSH			
(Symphoricarpos occidentalis)	2	0-10	17
FORBS			
NEVADA BULRUSH			
(Scirpus nevadensis)	2	0-11	17
LINEAR-LEAVED PLANTAIN			
(Plantago elongata)	2	0-7	33
COMMON PEPPER-GRASS			
(Lepidium densiflorum)	1	0-5	33
GRASSES			
SALT GRASS			
(Distichlis stricta)	35	20-69	100
WESTERN WHEAT GRASS			
(Agropyron smithii)	16	0-33	67
BLUE GRAMA GRASS			
(Boutelua gracilis)	9	0-32	33
SANDBERG BLUEGRASS			
(Poa sandbergii)	6	0-17	67
ALKALI BLUEGRASS			
(Poa juncifolia)	3	0-15	17
KENTUCKY BLUEGRASS			
(Poa pratensis)	2	0-15	17
NEEDLE-AND-THREAD			
(Stipa comata)	2	0-8	50
FOXTAIL BARLEY			
(Hordeum jubatum)	2	0-11	17

ENVIRONMENTAL VARIABLES

RANGE SITE:
SALINE LOWLAND 2

SOILS:
ORTHIC REGOSOL (ORION), ORTHIC REGOSOL(BULLPOUND)

SOIL DRAINAGE:
WELL DRAINED
MODERATELY WELL DRAINED

SLOPE :
NEARLY LEVEL
VERY GENTLE
GENTLE

ASPCET:
N/A

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rates
0.12 AUM/ac

Western Wheat Grass - Salt Grass - Gumweed **DMGA45**

(Agropyron smithii - Distichlis stricta - Grindelia squarrosa) Herbaceous

n=3 This is a disturbed plant community on overflow and saline lowland range sites in the Dry Mixedgrass subregion and is a seral plant community to DMGC1. This community type normally supports silver sagebrush, northern and western wheatgrass since these species are well adapted to re-colonizing disturbed overflow sites, given their rhizomatous root systems, affinity to the enhanced moisture levels on overflow sites and tolerance of salinity. In this community type, western wheatgrass is particularly well adapted to the increase in disturbance. Green needle grass is expected to more prevalent on overflow sites in the moister portions of the Dry Mixedgrass subregion. This community displays an increased abundance of a number of disturbance species including a gumweed and a number of annual forbs.

Soil Exposure: 51 % (40-71) **Moss/Lichen Cover:** 0 % (0-0) **Total Vegetation:** 55% (40-75)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
SHRUBS			
SILVER SAGEBRUSH *(Artemisia cana)*	2	0-6	33
FORBS			
LAMB'S QUARTERS *(Chenopodium album)*	7	0-21	33
FREMONT'S GOOSEFOOT *(Chenopodium fremontii)*	4	0-11	33
GUMWEED *(Grindelia squarrosa)*	3	0-7	67
POVERTYWEED *(Iva axillaris)*	2	0-5	33
GRASSES			
WESTERN WHEAT GRASS *(Agropyron smithii)*	26	17-31	100
GREEN NEEDLE GRASS *(Stipa viridula)*	4	0-12	33
HOOKER'S OAT GRASS *(Helictotrichon hookeri)*	3	0-8	33
ALKALI CORD GRASS *(Spartina gracilis)*	3	0-8	33
SALT GRASS *(Distichlis stricta)*	2	0-5	67
GIANT WILD RYE *(Elymus piperi)*	2	0-6	33
SANDBERG BLUEGRASS *(Poa sandbergii)*	1	0-4	67

ENVIRONMENTAL VARIABLES

RANGE SITE:
OVERFLOW

SOILS: ORTHIC BROWN (PINHORN, MASINASIN)
BROWN SOLOD (HALLIDAY)
CUMULIC REGOSOL (MILK RIVER)

SOIL DRAINAGE:
WELL DRAINED
MODERATELY WELL DRAINED

SLOPE :
NEARLY LEVEL
GENTLE

ASPECT:
EASTERLY

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rates
0.2 AUM/ac

Needle and Thread - Blue Grama - Wheatgrasses - DMGA46

(Stipa comata - Boutelua gracilis - Agropyron spp.) Herbaceous

n=20 This is a late seral plant community on loamy range sites in the Dry Mixed grass on productive mid to lower slope locations and on north facing slopes and is associated with the reference plant community DMGA2. It also has a more general distribution on modal sites with moist loamy range sites including soil series like Cranford, Maisinasin and Pinhorn. Moderate grazing pressure may have reduced the amount of wheatgrass cover in the plant community making blue grama grass more abundant.

Soil Exposure: 7 % (0-27) **Moss/Lichen Cover:** 43 % (2-83) **Total Vegetation:** 65% (40-75)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
FORBS			
PASTURE SAGEWORT *(Artemisia frigida)*	4	0-15	80
SCARLET MALLOW *(Sphaeralcea coccinea)*	2	0-8	80
COMMON DANDELION *(Taraxacum officinale)*	2	0-7	65
GRASSES			
NEEDLE-AND-THREAD *(Stipa comata)*	24	11-64	100
BLUE GRAMA GRASS *(Boutelua gracilis)*	20	5-45	100
WESTERN WHEAT GRASS *(Agropyron smithii)*	19	11-40	100
NORTHERN WHEAT GRASS *(Agropyron dasystachyum)*	6	0-13	85
SANDBERG BLUEGRASS *(Poa sandbergii)*	5	0-15	90
JUNE GRASS *(Koeleria macrantha)*	4	0-10	80
LOW SEDGE *(Carex stenophylla)*	2	0-5	95
PLAINS REED GRASS *(Calamagrostis montanensis)*	2	0-14	45

ENVIRONMENTAL VARIABLES

RANGE SITE:
LOAMY - MOIST

SOILS:
ORTHIC BROWN (PINHORN, MASINASIN, CRANFORD)
ORTHIC DARK BROWN (LUPEN, PURESCAPE)

SOIL DRAINAGE:
WELL DRAINED
MODERATELY WELL DRAINED

SLOPE :
NEARLY LEVEL-VERY GENTLE
GENTLE

ASPECT:
NORTHERLY

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.2 AUM/ac

Needle and Thread - Blue Grama - Northern Wheatgrass - DMGA47

(Stipa comata - Boutelua gracilis - Agropyron dasystachium.) Herbaceous

n=15 This is a late seral plant community associated with moist loamy range sites and reference plant community DMGA2and is also associated with the soil series Cranford, Massinasin and Pinhorn. Like DMGA46, the cover of wheatgrasses is reduced by moderate grazing pressure and blue grama grass is more abundant. This plant community is still fairly productive and with proper stocking and rotational grazing a gradual shift back to great dominance of wheatgrasses would be expected. With heavy grazing pressure, this community will further shift towards DMGA48 which is dominated by blue grama and needle and thread grass.

Soil Exposure: 9 % (0-15) **Moss/Lichen Cover:** 33% (8-58) **Total Vegetation:** 62% (42-78)

Plant Composition Canopy Cover(%)

	Mean	Range	Const
Forbs			
Pasture Sagewort			
(Artemisia frigida)	6	0-16	93
Scarlet Mallow			
(Sphaeralcea coccinea)	2	0-11	87
Common Dandelion			
(Taraxacum officinale)	1	0-8	47
Moss Phlox			
(Phlox hoodii)	1	0-3	40
Wild Vetch			
(Vicia americana)	1	0-10	27
Grasses			
Needle-and-Thread			
(Stipa comata)	30	13-42	100
Blue Grama Grass			
(Boutelua gracilis)	22	6-35	100
Northern Wheat Grass			
(Agropyron dasystachyum)	9	0-28	87
Western Wheat Grass			
(Agropyron smithii)	4	0-9	87
Sandberg Bluegrass			
(Poa sandbergii)	4	0-12	93
June Grass			
(Koeleria macrantha)	4	0-13	87
Low Sedge			
(Carex stenophylla)	1	0-5	100

Environmental Variables

Range Site:
Loamy - Moist
Soils:
Orthic Brown (pinhorn, masinasin, cranford)

Soil Drainage:
Well drained
Moderately well drained
Slope :
Nearly Level-Very Gentle
Gentle

Forage Production (lb/ac)

Grass	Not Available
Forb	Not Available
Shrub	Not Available
Litter	Not Available
Total	Not Available

Ecologically Sustainable Stocking Rate
0.18 AUM/ac

Blue Grama - Needle and Thread - DMGA48

(Boutelua gracilis - Stipa comata) Herbaceous

n=19 This is a mid-seral plant community associated with DMGA2 on moist loamy range sites. This plant community is the product of heavy grazing pressure. The cover of both wheatgrass and needle-and-thread grass are diminished with an increase in soil exposure. Recovery of this plant community back towards DMGA46 or DMGA47 or DMGA2 may take many years. Other disturbance species are more abundant including plantain and dandelion.

Soil Exposure:16 % (0-40) **Moss/Lichen Cover:** 31% (0-74) **Total Vegetation:** 60% (39-78)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
FORBS			
PASTURE SAGEWORT *(Artemisia frigida)*	5	0-20	95
SCARLET MALLOW *(Sphaeralcea coccinea)*	3	0-9	89
PURSH'S PLANTAIN *(Plantago patagonica)*	2	0-30	68
COMMON DANDELION *(Taraxacum officianale)*	1	0-9	37
GRASSES			
BLUE GRAMA GRASS *(Boutelua gracilis)*	28	10-75	100
NEEDLE-AND-THREAD *(Stipa comata)*	24	9-42	100
SANDBERG BLUEGRASS *(Poa sandbergii)*	5	0-15	68
WESTERN WHEAT GRASS *(Agropyron smithii)*	3	0-10	79
JUNE GRASS *(Koeleria macrantha)*	3	0-12	79
NORTHERN WHEAT GRASS *(Agropyron dasystachyum)*	3	0-10	68
LOW SEDGE *(Carex stenophylla)*	1	0-3	89
THREAD-LEAVED SEDGE *(Carex filifolia)*	2	0-12	32

ENVIRONMENTAL VARIABLES

RANGE SITE:
LOAMY - MOIST

SOILS:
ORTHIC BROWN (MASINASIN)
BROWN SOLOD (HALLIDAY)BROWN
SOLODIZED SOLONETZ (HEMARUKA)
ORTHIC DARK BROWN (PURESCAPE)

SOIL DRAINAGE:
WELL DRAINED
MODERATELY WELL DRAINED
RAPIDLY DRAINED

SLOPE :
NEARLY LEVEL-VERY GENTLE
MODERATE-STRONG-VERY STRONG

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.15 AUM/ac

Silver Sagebrush/Western and Northern Wheatgrass DMGC1

(Artemisia cana - Agropyron smithii and dasystachyum) Shrub

n=2 This is the reference plant community for saline overflow range sites in the Dry Mixedgrass. This is a drier upland expression of the riparian type described by Thompson and Hansen (2002) which is found on older alluvial terraces on both broad and narrow flood plains and coalescing alluvial fans in valleys. Plant species composition can be very similar in the two variants but the riparian type produces taller shrubs (.75 to 1.5 m vs. .2 to .35 m), has much higher shrub canopy levels (39% vs 11%) and has greater soil exposure due to higher levels of sediment movement. For this type, western and northern wheatgrass are well adapted to re-colonizing disturbed overflow sites, given their rhizomatous root systems, with sediment additions or due to grazing impacts. Though there is limited information about Silver Sagebrush plant communities most sources agree that it provides an important structural layer with opportunities for food and shelter for many wildlife species.

Soil Exposure: 26%(4-48) **Moss/Lichen Cover:** 42%(0-83) **Total Vegetation:** 66%(51-81)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
SHRUBS			
SILVER SAGEBRUSH *(Artemisia cana)*	11	5-18	100
RABBITBRUSH *(Chrysothamnus nauseosus)*	3	0-7	50
FORBS			
FRINGED SAGEWORT *(Artemisia frigida)*	1	0-3	50
COMMON YARROW *(Achillea millefolium)*	1	0-1	50
SCARLET MALLOW *(Sphaeralcea coccinea)*	1	0-1	50
GRASSES			
NORTHERN WHEATGRASS *(Agropyron dasystachyum)*	15	5-24	100
WESTERN WHEATGRASS *(Agropyron smithii)*	15	0-31	50
GREEN NEEDLE GRASS *(Stipa viridula)*	4	0-8	50
JUNE GRASS *(Koelaria macrantha)*	2	1-3	100
PLAINS REED GRASS *(Calamagrostis montanensis)*	1	0-1	50
UNDIFFERENTIATED SEDGE *(Carex spp.)*	1	0-1	50

ENVIRONMENTAL VARIABLES

RANGE SITE
OVERFLOW (SODIC/SALINE)

SOILS
ORTHIC REGOSOLS (ORION)

ELEVATION:
850-975 M

SOIL DRAINAGE:
MODERATELY WELL DRAINED

SLOPE :
LEVEL
NEARLY LEVEL

ASPECT:
VARIABLE

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
TOTAL	
LITTER	400-500

Ecologically Sustainable Stocking Rate
0.23 AUM/ac

Silver Sagebrush/Western Porcupine Grass - Wheatgrass DMGC3

(Artemisia cana / Stipa curtiseta - Agropyron) Shrub Herbaceous

n=8 This type occupies non-saline overflow sites and very productive loamy range sites in the Dry Mixedgrass. In the case of overflow sites, both the site and overflow are likely are non-saline given the cover of both western porcupine grass and needle-and-thread grass. The presence of such vigorous and productive cover of western porcupine grass is an indicator of productive, dark brown chernozemic soils (Smoliak, Personal comm.). This is a minor type and somewhat rare in soil correlation area 1. Though silver sagebrush may be present at a low canopy cover (1-2%) it provides valuable structure for wildlife with plants ranging in height from 0.5 to 0.75 m Note that total vegetation cover is very high and with very little exposed soil.

Soil Exposure: 2 % (0-5) **Moss/Lichen Cover:** 20 % (2-69) **Total Vegetation:** 90% (71-98%)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
SHRUBS			
SILVER SAGEBRUSH (*Artemisia cana*)	4	0-7	75
FORBS			
PRAIRIE SAGEWORT *(Artemisia ludoviciana)*	1	0-2	75
PASTURE SAGEWORT *(Artemisia frigida)*	1	0-3	63
GRASSES			
WESTERN PORCUPINE GRASS *(Stipa curtiseta)*	44	21-77	100
NEEDLE-AND-THREAD *(Stipa comata)*	8	0-24	75
NORTHERN WHEATGRASS *(Agropyron dasystachyum)*	7	0-19	88
UNDIFFERENTIATED SEDGE *(Carex)*	5	0-17	88
JUNE GRASS *(Koeleria macrantha)*	5	0-17	88
SUN-LOVING SEDGE *(Carex pensylvanica)*	5	0-24	38
BLUE GRAMA GRASS *(Boutelua gracilis)*	3	0-9	88
WESTERN WHEAT GRASS *(Agropyron smithii)*	2	0-9	50
PLAINS REED GRASS *(Calamagrostis montanensis)*	1	0-5	75

ENVIRONMENTAL VARIABLES

RANGE SITE:
OVERFLOW

SOILS:
ORTHIC BROWN (COMREY, CHIN, BUNTON, PINHORN)

ELEVATION (M):
1025 (1022 - 1028)

SOIL DRAINAGE:
MODERATELY WELL DRAINED
WELL DRAINED

SLOPE :
GENTLE
MODERATE
VERY GENTLE, NEARLY LEVEL

ASPECT:
NORTHERLY
SOUTHERLY

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.3 AUM/ac

Creeping Juniper - Sedge DMGC4

(Juniperus horizontalis - Carex) Shrub

n=2 This is a very unique plant community within the Manyberries Badlands and is utilized as nesting habitat by Sage-Grouse within the overall silver sagebrush landscape of southeastern Alberta. The plant community is established on a badland range site, with more than 10 % bedrock exposure. The unique soil conditions where creeping juniper establishes is formed on slump materials of Bearpaw shales that accumulate on mid to lower slope positions and then are subject to wind and water erosion (McNeil, personal comm.). The clay soil peds are easily moved by wind and water. There appears to be enough moisture provided from winter snow trapping and from spring and summer overflow to support creeping juniper, that no other species are able to out compete. While the sites are barren in character, creeping juniper provides valuable vertical structure on the site.

Soil Exposure: 87 % (79-95) **Moss/Lichen Cover:** 3 % (1-5) **Total Vegetation:** 17% (10-25%)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
SHRUBS			
CREEPING JUNIPER *(Juniperus horizontalis)*	7	2-11	100
COMMON WILD ROSE *(Rosa woodsii)*	1	0-2	50
FORBS			
GOLDEN BEAN *(Thermopsis rhombifolia)*	1	1-2	100
YELLOW UMBRELLA PLANT *(Eriogonum flavum)*	1	1-2	100
GRASSES			
UNDIFFERENTIATED SEDGE *(Carex)*	2	0-4	100
SAND GRASS *(Calamovilfa longifolia)*	1	0-1	100
WESTERN WHEAT GRASS *(Agropyron smithii)*	1	0-1	100

ENVIRONMENTAL VARIABLES

RANGE SITE
BADLAND

ELEVATION (M):
1026 (1016-1035)

SOILS:
ORTHIC REGOSOL (ZER)

SOIL DRAINAGE:
WELL DRAINED

SLOPE :
MODERATE
STRONG

ASPECT:
VARIABLE

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rate
0.05 AUM/ac

Wild Rose/Needle-and-Thread -Sand Grass-Low Sedge - DMGC5

(Rosa woodsii/Stipa comata-Calamovilfa longifoliz-Carex stenophylla) Shrub

n=36 This is a late seral to reference plant community for choppy sandhills range sites in the Dry Mixedgrass. This community type is associated with high relief, parabolic dunes in the Suffield area. The community represents a relatively well stabilized cover type on gentle, moderate and strong slopes. Sandhill communities have received limited study in southeastern Alberta (Axys 2001). It is possible that this is a late seral community at best, given the relatively high abundance of rose and snowberry and much lower cover of choke cherry and other grazing-sensitive shrubs. Soil exposure on this type is highly variable.

Soil Exposure: 26% (2-91) **Moss/Lichen Cover:** 1% (1-6) **Total Vegetation:** 64% (2-93%)

Plant Composition Canopy Cover(%)

	Mean	Range	Const
Shrubs			
Common Wild Rose *(Rosa woodsii)*	6	0-44	53
Snowberry *(Symphoricarpos occidentalis)*	5	0-45	31
Silver sagebrush *(Artemisia cana)*	2	0-18	31
Forbs			
Scurf Pea *(Psoralea lanceolata)*	6	0-36	64
Pasture sagewort *(Artemisia frigida)*	3	0-25	44
Golden aster *(Heterotheca villosa)*	1	0-21	36
Goosefoot *(Chenopodium pratericola)*	1	0-7	64
Grasses			
Needle-and-thread *(Stipa comata)*	26	0-63	100
Sand grass *(Calamovilfa longifoliz)*	14	0-71	75
Low Sedge *(Carex stenophylla)*	12	0-57	75
Blue Grama *(Bouteloua gracilis)*	6	0-38	56
Northern wheat grass *(Agropyron dasystachyum)*	4	0-20	53
June grass *(Koeleria macrantha)*	3	0-18	61

Environmental Variables

Range Site:
choppy sandhills

Soils:
Orthic regosol (Antelope)
Regosol brown (Vendisant)

Elevation (m):

Soil Drainage:
Rapidly drained

Slope :
Gentle, Moderate, Strong

Aspect:

Forage Production (lb/ac)

Grass	Not Available
Forb	Not Available
Total	Not Available
Litter	Not Available

Ecologically Sustainable Stocking Rate
0.15 AUM/ac

Choke Cherry/Northern Wheatgrass - June Grass DMGC6

(Prunus virginiana/Agropyron dasystachium-Koeleria macrantha) Shrub

n=2 This is a reference plant community for a patch type in choppy sandhills range sites in the Dry Mixedgrass. This community occurs on stabilized, steep, north slopes. Choke Cherry is a valuable browse species in this setting.

Soil Exposure: 8% (6-10) **Moss/Lichen Cover:** 1% (0-1) **Total Vegetation:** 84% (77-90%)

Plant Composition Canopy Cover(%)

	Mean	Range	Const
Shrubs			
Choke cherry *(Prunus virginiana)*	14	7-21	100
Buckbrush *(Symphoricarpos occidentalis)*	7	1-13	100
Common wild rose *(Rosa woodsii)*	6	5-6	100
Saskatoon *(Amelanchier)*	4	0-9	50
Forbs			
Scurf Pea *(Psoralea lanceolata)*	3	0-7	100
Golden bean *(Thermopsis rhombifolia)*	2	1-3	100
Pasture sagewort *(Artemisia frigida)*	2	0-3	50
Grasses			
Northern wheat grass *(Agropyron dasystachyum)*	56	51-60	100
June grass *(Koeleria macrantha)*	4	2-5	100
Beaked sedge *(Carex rostrata)*	1	1-1	100
Rocky mountain fescue *(Festuca saximontana)*	1	0-1	50

Environmental Variables

Range Site:
choppy sandhills

Soils:
Orthic Regosol (Antelope)
Regosol Brown (Vendisant)

Elevation (m):

Soil Drainage:
Rapidly drained

Slope :
Strong, Steep

Aspect:
Northerly

Forage Production (lb/ac)

Grass	Not Available
Forb	Not Available
Total	Not Available
Litter	Not Available

Ecologically Sustainable Stocking Rate
0.16 AUM/ac

Greasewood /Salt Grass - Western Wheat Grass DMGC7

(Sarcobatus vermiculatus/Distichlis stricta - Agropyron smithii) Shrub

n=4 This is the reference plant community for sodic and saline overflow sites in the Dry Mixedgrass. Greasewood is associated with site conditions somewhat similar to silver sagebrush, but with particularly high levels of sodicity and ph levels greater than 8. Soil chemistry limits forage productivity on these sites. Soil exposure is similar to saline overflow and saline lowland range sites. Greasewood likely provides valuable structure for wildlife. This community should be grazed conservatively since vegetation canopy is sparse with a considerable amount of naturally occuring bare soil.

Soil Exposure: 37 % (9-51) **Moss/Lichen Cover:** 1 % (0-0.3) **Total Vegetation:** 56%(51-72)

PLANT COMPOSITION CANOPY COVER(%)

	MEAN	RANGE	CONST
SHRUBS			
GREASEWOOD			
(Sarcobatus vermiculatus)	12	9-15	100
NUTTALL'S ATRIPLEX			
(Atriplex nuttallii)	4	0-10	50
FORBS			
COMMON PEPPER-GRASS			
(Lepidium densiflorum)	3	0-5	75
LINEAR-LEAVED PLANTAIN			
(Plantago elongata)	1	0-3	75
GRASSES			
SALT GRASS			
(Distichlis stricta)	16	5-31	100
WESTERN WHEAT GRASS			
(Agropyron smithii)	12	4-19	100
BLUE GRAMA GRASS			
(Boutelua gracilis)	4	0-8	50
SANDBERG BLUEGRASS			
(Poa sandbergii)	3	0-8	50
NUTTALL'S SALT-MEADOW GRASS			
(Puccinellia nuttalliana)	2	0-5	75
CREEPING SPIKE-RUSH			
(Eleocharis palustris)	2	0-6	25
ALKALI BLUEGRASS			
(Poa juncifolia)	2	0-3	50
LOW SEDGE			
(Carex stenophylla)	1	0-4	50

ENVIRONMENTAL VARIABLES

RANGE SITE:
OVERFLOW (SODIC AND SALINE)

SOILS: (ASSOCIATED WITH)

ORTHIC BROWN (PINHORN-MASINASIN-BUNTON); ORTHIC REGOSOL (ORION)
BROWN SOLODIZED SOLONETZ (WARDLOW)

SOIL DRAINAGE:
WELL DRAINED
MODERATELY WELL DRAINED

SLOPE :
LEVEL
NEARLY LEVEL ,VERY GENTLE

FORAGE PRODUCTION (LB/AC)

GRASS	NOT AVAILABLE
FORB	NOT AVAILABLE
SHRUB	NOT AVAILABLE
LITTER	NOT AVAILABLE
TOTAL	NOT AVAILABLE

Ecologically Sustainable Stocking Rates
0.15 AUM/ac

7.0 Guidelines for assessing plant community structure, soil exposure and litter abundance and noxious weeds.

The following guidelines are designed for use with the Range Health Assessment for Grassland, Forest and Tame Pastures - Field Workbook (Adams et al. 2003). The range health protocol is available from the Rangeland Management Branch, Public Lands and Forests Division, Alberta Sustainable Resource Development as a field workbook in 2003. The following comments are to assist the user in interpreting the range health codes and instructions in the Mixedgrass Natural Subregion.

7.1 Question 1. Integrity and Ecological Status

Why is plant species composition important?

Plant species composition is a fundamental consideration in range health assessment. Plant species composition will influence a sites' ability to perform functions and provide products and services. Native plant communities evolve within their environment and slowly change over time as environmental factors change. Significant short term changes in plant composition do not normally occur unless caused by significant disturbances like continuous heavy grazing, prolonged drought, prolonged high periods of precipitation, exotic species invasion, frequent burning or a timber harvesting treatment.

Changes in plant community may result from disturbance?

Plant species changes due to grazing pressure are predictable:

Perennial species that tend to be most productive and palatable, are also the most sensitive to grazing and will decline with increased grazing pressure.

Species with lower forage value and greater adaptation to grazing pressure will increase in relative abundance.

Eventually very heavy grazing pressure will lead to weedy species that are adapted to more constant levels of disturbance.

What successional stages should we manage for?

Range management objectives tend to favor the later stages of plant succession (late-seral to reference plant community or good to excellent range condition). Late seral plant communities tend to be superior in the efficient capture of solar energy, in cycling of organic matter and nutrients, in retaining moisture, in supporting wildlife habitat values and in providing the highest potential productivity for the site. Early seral stages represent plant communities with diminished ecological processes, that are less stable and more vulnerable to invasion by weeds and non-natives species. They are also characterized by diminished resource values such as livestock forage production, wildlife habitat values and watershed protection.

How do management changes affect plant communities?

When disturbance impacts are reduced or removed, the present plant community may react in a number of ways. It may appear to remain static, or it may move toward a number of identifiable plant communities including the potential natural community. Some rangeland communities due to disturbance history or a natural process of invasion, have become dominated by non-native species, called modified plant communities. To the best of our knowledge, long-term rest of these modified plant communities will not facilitate a return to a native plant community. When non-native plant communities are being evaluated, a separate set of questions are applied to determine the health status of modified plant communities.

How can I tell the ecological status of a plant community?

The plant community tables provide guidance in understanding the ecological status of a given plant community:

- **Reference Plant Community(RPC) Types** - plant communities considered to be the expression of potential natural community for the site. Where the the RPC is unknown, a late seral plant community will occur instead.

- **Successional Plant Community Types** - identifies, those communities that are seral to the RPC. These communities have had some modification due to disturbance. Seral status declines as you move down the column. Successional community types are not always defined.

- **Modified Plant Community Types** - are also seral plant communities to the RPC, but where disturbance history has altered the plant communities to a non-native or modified character. Cultivated and seeded plant communities may be included in this category and are denoted by the letter code - **Cu.**

7.2 Question 2 - Plant Community Structure

What is plant community structure and why is it important?

This parameter recognizes the importance of structure associated with the canopy cover of major life form groups (trees, shrubs, forbs and graminoids) in a plant community. A diverse plant community supports optimum nutrient cycling and energy flow. Different life forms or life form groups vary in canopy structure and rooting depths, using sunlight, water and nutrients from different zones in the vegetation canopy and soil. Plant community structure is important in maintaining net primary production, especially in forested rangelands, and in the maintenance of habitat values for a spectrum of wildlife species including browsing opportunities for ungulates, and feeding and nesting sites for breeding birds.

Scoring Plant Community Structure in the Mixedgrass Natural Subregion

- Dry Mixedgrass plant communities are characterized by mid-grass structure and may also include shrubs species like snowberry, rose and silver sagebrush.

- Mid-grasses that best express plant community structure in the Dry Mixedgrass include needle and thread, northern and western wheatgrass, western porcupine grass and green needle grass.

- Needle-and-thread grass is perhaps the most common mid-grass in the Dry Mixedgrass, but is normally lower in stature than the other mid-grasses.

- The presence of a high canopy cover of blue grama, June grass or Sandberg's bluegrass normally denotes a significant loss of plant community structure, unless the site is an exposed knoll top or thin break range site.

7.3 Question 3 - Does the site retain moisture (litter standards)

What is litter and how does it contribute to range health?

When functioning properly, a watershed captures, stores and beneficially releases the moisture associated with normal precipitation events. Uplands make up the largest part of the watershed and are where most of the moisture received during precipitation events is captured and stored. Live plant material from both vascular and non-vascular plants and **litter,** residual plant material, either standing, freshly fallen or slightly decomposed on the soil surface, is strongly linked to range health. Litter cover aids a number of important functions on rangeland including: water infiltration (slowing runoff and creating a path into the soil), reducing soil erosion from wind and water, reducing evaporative losses and reducing raindrop impact.

In grassland environments significant incoming precipitation is lost as evapo-transpiration. Litter acts as a physical barrier to heat and water flow at the soil surface. Litter conserves moisture by reducing evaporation making scarce moisture more effective. Studies show that forage yields are reduced by about 30 % during dry years when litter has been removed by fire or heavy grazing on foothill rangelands (Willms et. al 1986). Table 16 summarizes litter normals for the Mixedgrass Natural Subregion. Like climate normals, litter normals will be adjusted and refined over time as additional years of monitoring add to the normals.

How much is enough?

Our basic assumption is that healthy grazed sites that provide optimum grazing opportunities will have a characteristic litter level that will be maintained over time with light to moderate stocking rates. By monitoring a variety of different ecological range sites over time, we are able to establish a "litter normal" expressed as lb./ac. The litter normals recommended for the Mixedgrass Natural Subregion are summarized in table 11. The litter normal relates to the potential productivity of lightly to moderately grazed sites.

- Most loamy range sites in the Mixedgrass will be Orthic Dark Drown Chernozems
- Threshold values should be viewed as a starting point, a minimum level for establishing a basic level of moisture retention.
- While excessive litter may build up on black soil types, there do not appear to be any detrimental effects on grassland health in the Mixedgrass from having "too much" litter
- Modified plant communities have a diminished potential to produce adequate litter levels since the non-native plant material is much more prone to weathering loss.

Table 11. Litter normals for the Dry Mixedgrass Natural Subregion

Range Site	Litter Normal	Healthy >65% of normal	Healthy with problems 65 to35% of normal	Unhealthy <35% of normal	Data Source[1]	Litter Values (lb./ac.)	n= years collected
Loamy and Sandy	400	>260	260-140	<140	• Antelope Cr.	388	14
					• Lomond	569	12
					• Murray Lk.	265	12
					• Rainy Hills	266	14
					• Schuler	303	14
					• Turin	220	14
					• Vauxhall	679	12
					• Wildhorse	509	14
Blowout	250	>160	160-85	<85	• Cressday	172	14
					• Sage Creek	258	14
Thin Breaks	150	>95	95-50	<50			

[1] Rangeland Reference Area Site, Alberta Sustainable Resource Development, Rangeland Management Branch, Lethbridge.

7.4 Question 4. - Site/Soil Stability - Why is soil loss a concern for rangeland health?

Rangelands experience varying degrees of natural stability depending on climate, soil, topography and plant cover. The normal amount of sediment that will be produced by water and wind erosion processes from a particular site type is termed geologic erosion. Managers strive to prevent accelerated erosion due to land management practices, by maintaining adequate vegetation cover and a minimum of exposed soil. Vegetation protects the soil surface from raindrop impact, it detains overland flow, maintains infiltration and permeability and protects the soil surface from erosion. Soil loss is a serious concern since erosion tends to remove the most valuable fractions from the soil, the finer lighter particles like clays, silts and organic matter which are most important to soil fertility and moisture holding capacity. Long term studies show that ongoing soil loss due to overgrazing or other practices, will eventually transform the soil to a shallower, drier, less productive and less stable soil type. Excess sediment production has a negative impact on water quality since the fine particles that are eroded have great potential to absorb and carry nutrients and chemicals.

Loamy range sites tend to have very low levels of natural soil exposure (Table 12). It will be relatively easy to recognize human cause bare soil and accelerated erosion where soil exposure levels are normally in the 3-7% range. Ecological sites that are normally unstable, will tend to exhibit significant exposed soil and have shallow soil profiles (seepage and slumping areas, badlands, thin breaks, saline lowlands, solonetzic soils, some sandy soils). In these examples, training and experience is required to make accurate assessments of human caused bare soil and accelerated erosion.

Human caused bare soil is rated by considering the total bare soil on a range site minus the amount that is normally naturally occurring. Table 12 shows the normal range of mean soil exposure values observed in the plant community data. Loamy, sandy and shallow-to-gravel sites, normally have less than 10% soil exposure. Higher amounts of exposed soil can be expected on blowout, sands, thin breaks and saline lowlands.

Table 12. Soil exposure normals for major range sites in the Dry Mixedgrass Natural Subregion.

Range Sites	Expected Soil Exposure (% canopy cover)
Overflow (non-saline)	**2-4**
Overflow (saline)	**15-25**
Clayey	**35-40**
Loamy	**6-13**
Sandy	**6-28**
Blowout (solodic expression)	**6-13**
Blowout (solonetzic expression)	**20-30**
Sands	**22-24**
Choppy Sandhills	**20-25**
Shallow-to-Gravel	**8-12**
Limy	**10-13**
Gravel	**8-12**
Thin Breaks	**22-30**
Saline Lowlands	**40-75**
Badlands	**45-85**

7.5 Question 5 - Noxious weed infestation.

Noxious weeds are invasive plants that are alien species to the rangeland plant community. Weeds are seldom a problem in vigorous, well managed pastures although weed invasion may occasionally happen in healthy stands. Weeds may be introduced to relatively healthy stands through rodent burrows, but generally their presence indicates a degrading plant community. Noxious weeds diminish the agricultural productivity of a site, and threaten biological diversity, the structure, function, and sustainability of ecosystems. They diminish the multiple uses and values that range is normally capable of providing.

Weeds normally provide a strong message about range health. Weeds most often invade range where grazing practices have resulted in available niche space (bare soil, surplus moisture); available micro-habitats normally occupied by range plants, but now available to weeds due to overgrazing or some other land use or natural disturbance. Grazing management strives to maintain plant vigor and vegetation cover so that all niche space is filled by one or more plant speices that can occupy the site and thereby minimize weed invasion.

Rating noxious weed infestations should be guided by local weed lists of noxious weeds as provided by municipal weed control authorities. This question attempts to identify noxious (restricted weeds) infestation on a range site.

In the analysis of plot data(Table 13), four noxious weeds were encountered including Canada thistle, leafy spurge, tall buttercup and toadflax. Several nuisance weeds were also encountered including perennial sow thistle and annual hawk's beard. Canada thistle was the most common occurring in about 5 percent of plots. On highly disturbed sites it occurred at up to 10 % canopy cover. All other weed species occurred at trace levels of frequency and cover.

Table 13. Percent Frequency[1] of Noxious and Nuisance Weeds in Range Vegetation Inventory Plots by Natural Subregion and in Riparian Plots in Southern Alberta.

Natural Subregion n=sample plots	Canada Thistle	Tall Buttercup	Hound's Tongue	Toadflax	Perennial Sow Thistle
Dry Mixedgrass n=1716	**1**	**0**	**0**	**0**	**0**
Mixedgrass n=724	5	0.3	0.3	0.1	0
Foothills Fescue n=283	17	1	T	T	2
Foothills Parkland n=410	17	1	0	0	1

[1] Frequency means species are present in plots but does not imply infestation levels of the species in the transect

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APPENDIX 9.1 ECOLOGICAL RANGE SITE DEFINITIONS

Table 14. Ecological/range sites, with definitions and abbreviated AGRASID correlations. From McNeil (2003).

ZEcological/ Range Site	Revised Definition	AGRASID 3.0 Correlation
Subirrigated (Sb)	Water table is close to surface during growing season, but rarely above.	Gleyed non-saline medium- to coarse-textured soils.
Riparian (Ri)	Zone most closely adjacent to stream and river channels. Also known as the lotic zone.	Any SLM with floodplain or stream channel landscape model (FP1,FP2, FP3, SC1-l, SC1-h, SC2, SC3or SC4)
Overflow (Ov)	Areas subject to water spreading and sheetflow. Typically on gentle inclines or terraces prone to stream overflow.	Inclined, low relief landscapes including fans and aprons; or soils developed on fans, aprons or terraces.
Wetland (WL)	Typically low-lying or depressional positions subject to occupation by water ranging from temporary to semi-permanent in duration. Also known as the lentic zone.	Non or weakly saline Gleysols or Organic soils. OR undifferentiated water bodies (ZWA) with any landscape model **except** W1, W2 or W3.
Clayey (Cy)	Clayey textured soils including silty clay, sandy clay, clay, and heavy clay. Generally >40% clay.	Fine- and very-fine-textured soil groups.
Loamy (Lo)	Includes loam, silt loam, silt, clay loam, sandy clay loam, and silty clay loam.	Medium- and moderately-fine textured soil groups.
Sandy (Sy)	Sandy-loam-textured soils.	Moderately coarse soil group.
Limy (Li)	Eroded or immature soils with free lime ($CaCO_3$) at the soil surface. Soil pH generally >7.5.	Eroded, Rego and Calcareous soils or subgroups.
Sand (Sa)	Loamy sand and sand soils, and not with a duned surface.	Very-coarse-textured soil group and not on duned landscape models.
Blowouts (BlO)	Areas with eroded surface pits reflecting the presence of abundant Solonetzic (hardpan) soils.	Dominant or Co-dominant Solonetzic Order Soils.
Choppy Sandhills (CS)	Loamy sand and sand soils with a duned land surface.	Very-coarse-textured soil groups with duned landscape models.
Thin Breaks (TB)	Areas with bedrock at or near the soil surface; largely vegetated. May include thin, eroded or immature soils on gentle to steep landscapes.	Landscape models I3m and I3h; OR layered, medium, or fine materials with mas pm of L6, L7, L8, L16, M5, or F5.
Shallow to Gravel (SwG)	Soil with 20 to 50 cm of a sandy or loamy surface overlying a gravel or cobble- rich substrate.	Layered materials denoted by mas pm (parent material) codes L4 or L5.
Saline Lowland (SL)	Areas with negligible vegetation due to electrical conductivity (salts) and/or	Saline Regosolic or Saline Gleysolic series OR sodic

[Z]Ecological/ Range Site	Revised Definition	AGRASID 3.0 Correlation
	sodium adsorption ratio limitations.	Regosolic series.
Gravel (Gr)	Dominated by gravels or cobbles (>50% coarse fragments). May be covered by a mantle with few gravels, up to 20 cm thick.	Layered or coarse materials with mas pm codes L1, L17, L19, L21 or C1.
Badlands/ Bedrock (BdL)	Nearly barren lands with exposures of softrock or hardrock. Includes steep valley walls.	Specific Landscape Models I4h, I5.

[Z]Ecological/range sites are listed in order from most productive to least productive.

APPENDIX 9.2 A CONCISE GUIDE FOR USERS OF AGRASID

APPENDIX 9.2.1 - AGRASID: SOIL LANDSCAPE MODELS

AGRASID 3.0 is the most recent version of the Agricultural Region of Alberta Soil Information Database (ASIC 2001). AGRASID is a digital compilation of soils and landscapes presented at a scale of 1:100,000.

The basic soil map unit of AGRASID is the Soil Landscape Model (SLM) (ASIC 2001). Soil Landscape Models include soil series codes, a unit number, and a landscape model (Figure 6). Soil series proportions in a polygon or SLM are either dominant (50 to 100%), co-dominant (30 to 50%), or significant (10 to 30%).The soil series code in SLMs in which one soil series is dominant are denoted with three-letter symbols.The soil series code in SLMs in which two or three soil series are co-dominant are denoted with four-letter codes, with the first two letters indicating the first co-dominant soil and the last two letters indicating the second co-dominant soil. For example, an SLM with the soil series symbols CFMB indicates a co-dominant Cranford (CFD, Orthic Brown Chernozem) developed on medium glacial lacustrine and, Maleb (MAB, Orthic Brown Chernozem) developed on glacial till parent material.

A soil model unit number between 1 and 21 following the soil series symbol generally indicates a significant component of a particular soil or soils (Table 15).

Examples of Soil Model Numbers Used in Soil Landscape Models

- A simple SLM with one dominant soil (CFD) is indicated as CFD1/U1l. The soil model number 1 indicates a relatively pure unit with no significant identified soils. The landscape model U1l indicates a low-relief undulating landscape with slopes generally less than 2%.

- A complex SLM with two co-dominant soils (CFD and MAB) is indicated as CFMB2/U1h-c. The soil model number 2 indicates a significant proportion of wet soils (Gleysols or gleyed subgroups). The landscape model U1h indicates undulating topography (slopes of 2 to 5%). The c modifier refers to the presence of channels (Table 19).

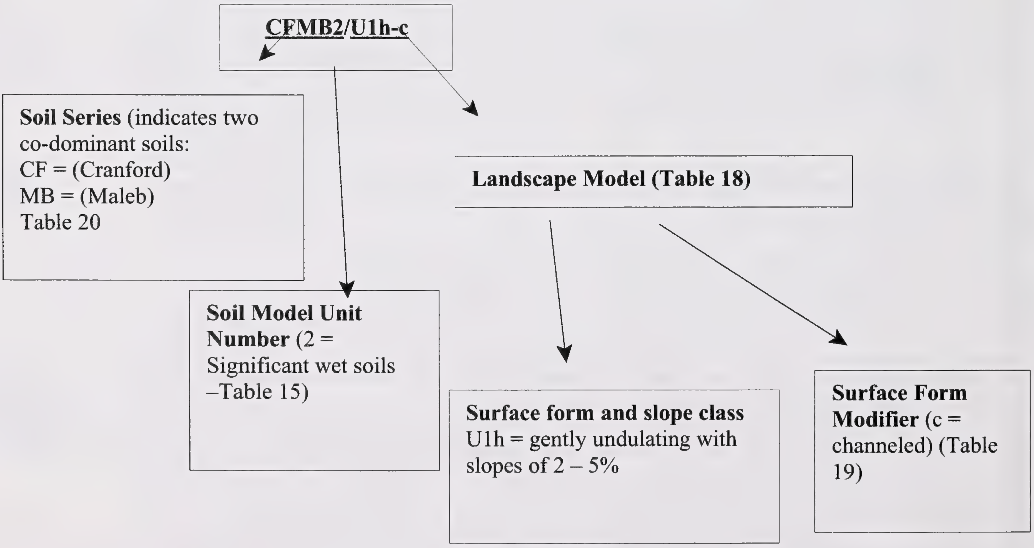
CFMB2/U1h-c
Soil Series (indicates two co-dominant soils:
CF = (Cranford)
MB = (Maleb)
Table 20
Landscape Model (Table 18)
Soil Model Unit Number (2 = Significant wet soils –Table 15)
Surface form and slope class U1h = gently undulating with slopes of 2 – 5%
Surface Form Modifier (c = channeled) (Table 19)

Fig. 6 An example of an SLM code.

9.2.2 SOIL MODEL UNIT NUMBERS

Table 15. Description of Soil Model Unit Numbers.

Soil Model Unit Number	Significant Soil	Additional Description
1	Relatively pure unit.	No significant soils identified.
2	Wet, including gleyed subgroups, Gleysols or Organics	Gleyed are imperfectly drained; Gleysols and Organics are usually poorly or very poorly drained
3	Saline or salt-enriched	Saline phase or Saline subgroups
4	Eroded, Rego or Calcareous	Eroded and Thin phases, Rego or Calcareous subgroups
5	Finer textured	Soils must be at least one textural group finer (refer to textural triangle, Fig. 4) than the dominant or co-dominant soils.
6	Coarser textured	Soils must be at least one textural group coarser (refer to textural triangle, Fig. 4) than the dominant or co-dominant soils.
7	Solonetzic order	hardpan layer affected by sodium enrichment
8	Wet (2) and Eroded, Rego and Calcareous soils (4)	Both Soil Model Units 2 and 4 are present in significant proportions
9	Wet (2) and coarser (6)	Both Soil Model Units 2 and 6 are present in significant proportions
10	Wet (2) and Solonetzic (7)	Both Soil Model Units 2 and 7 are present in significant proportions
11	Eroded, Rego and Calcareous soils (4) and coarser textured (6)	Both Soil Model Units 4 and 6 are present in significant proportions
12	Wet (2), Eroded, Rego and Calcareous (4) and coarser textured (6)	The three Soil Model Units 2, 4 and 6 are present in significant proportions
13	Significant saline soils (3) and eroded Rego and Calcareous soils (4).	Both Soil Model Units 3 and 4 are present in significant proportions
14	Eroded, Rego and Calcareous (4) and Solonetzic (7)	Both Soil Model Units 4 and 7 are present in significant proportions
15	Coarser textured (6) and Solonetzic (7)	Both Soil Model Units 6 and 7 are present in significant proportions
16	Chernozemic only if the dominant or co-dominant soils are Brunisolic, Luvisolic, Vertisolic, Regosolic, Solonetzic and/or Gleysolic	Significant Chernozemic soils in polygons dominated by soils of other orders.
17	Significant finer-textured soils (5) and significant Solonetzic soils (7).	Both Soil Model Units 5 and 7 are present in significant proportions
18	Wet (2) and finer-textured (5)	Both Soil Model Units 2 and 5 are present in significant proportions
19	Wet (2) and Chernozemic (16) only if the dominant or co-dominant soils are of a non-Chernozemic order.	Both Soil Model Units 2 and 16 are present in significant proportions
20	Imperfectly or freely drained soils (Gleyed subgroups) only if dominant or co-dominant soils are of the Gleysolic or Organic orders.	Dominantly poorly or very poorly drained soils, with significant non-Chernozemic soils that are either imperfectly or freely drained.
21	Dominant or two codominant Gleysolic soils with significant Organic soils.	Dominated by mineral wetland soils with significant areas of peat accumulation.

Variants

Variants of Soil Series are indicated as modifiers following the Soil Series code. Three examples are listed below. For a complete list of the 48 possible variants, see ASIC 2001.

co:	Coarse-textured variation of the noted soil series. Textural class is at least one group coarser (Fig. 5). e.g., BZR is medium-textured, so a BZRco indicates at least a moderately-coarse-textured variation.
gl:	Gleyed phase of the noted soil series. Soils are generally imperfectly drained, indicative of temporary wetlands. May also be indicative of a high watertable, which can promote subirrigation.
st:	Stony phase used to indicate surface stoniness class of S3 or greater. Selected classes are defined in Table 16.

Table 16. Selected stoniness classes.

Stoniness Class	Description	% of Land Surface Covered By ^{Z}Stones or Boulders
S3	very stony	3 – 15
S4	excessively stony	15 – 50
S5	exceedingly stony	>50

^{Z}Stones are 25 to 60 cm in diameter; boulders are >60 cm in diameter.

Undifferentiated Soil Models

Some soil landscapes are complex and may contain a wide variety of soil series. For these conditions undifferentiated soil models are used. Undifferentiated soil models begin with the letter Z, and reflect a broad grouping of particular soils that can include a soil order (e.g., ZSZ for Solonetzic), a soil subgroup (e.g., Gleyed is a component of ZGW), or a broad soil textural group (e.g., ZCO for coarse soils, Fig. 1). Nine undifferentiated soil models were used in AGRASID (Table 17).

Table 17. Description of Undifferentiated Soil Models.

Undifferentiated Soil Model Code	Description	Undifferentiated Soil Model Code	Description
ZCO	Coarse soils (gravel and sand)	ZNA	Saline soils
ZER	Eroded mineral soils including Regosols and Rego and Calcareous subgroups	ZOR	Organic soils
ZFI	Finer-textured soils (finer than indicated by series)	ZSZ	Solonetzic order soils
ZGW	Gleyed subgroups, Gleysols and water	ZUN	Undifferentiated mineral soils
		ZWA	Water bodies

9.2.3 Landscape Models

Landscape Models reflect landform, surface shape, slope and relief. (Table 18). They are usually denoted with a capital letter followed by a number followed by a small letter. For a complete listing of landscape models, please refer to AGRASID Version 3.0 (ASIC 2001). Landscape models pertinent to Organic soil areas are not included for Range Guides of the Grassland Natural Region.

Table 18. Definition of Selected Landscape Models.

Code	Definition of Landscape Model	Predominant Slope Range (%)
DL	Disturbed land, including communities and facilities.	
D1l	Low-relief longitudinal dunes.	2 – 9
D1m	Moderate-relief longitudinal dunes.	5 – 15
D1h	High-relief longitudinal dunes.	9 – 30
D2l	Low-relief parabolic dunes.	2 – 9
D2m	Moderate-relief parabolic dunes.	5 – 15
D2h	High-relief parabolic dunes.	9 – 30
FP1	Unconfined meander floodplain.	0 – 5
FP2	Unconfined braided channel.	0 – 5
FP3	Confined floodplain with or without low-level terraces.	0 – 5
HR2m	Moderate-relief hummocky and ridged.	5 – 15
HR2h	High-relief hummocky and ridged.	9 – 30
H1l	Low-relief hummocky.	4 – 9
H1m	Moderate-relief hummocky.	7 – 15
H1h	High-relief hummocky.	12 – 30
H5l	Low-relief hummocky draped moraine over softrock.	4 – 9
H5m	Moderate-relief hummocky draped moraine over softrock.	7 – 15
H5h	High-relief hummocky draped moraine over softrock.	12 – 30
I3l	Inclined, generally single slope landform, including fans and aprons.	2 – 9
I3m	Inclined; generally single slope moderate-relief landform.	6 – 15
I3h	Inclined and steep; generally single slope high relief landforms with 0 to 10% exposed bedrock.	15 – 60
I4l	Inclined; generally single slope low-relief landforms with >10% exposed softrock.	2 – 9
I4m	Inclined; generally single slope moderate-relief landforms with >10% exposed softrock.	6 – 15
I4h	Inclined and steep; generally single slope high-relief landforms with >10% exposed softrock.	15 – 60
I5	Inclined steep with extensive failure slumps.	15 – 60
IUl	Combination of inclined and undulating; generally a wavy pattern of gentle slopes on an overall inclined landscape.	1 – 5
IUh	Combination of inclined and undulating to hummocky; generally a wavy pattern of gentle to moderate slopes on an overall inclined landscape.	3 – 9
L1	Level plain.	0 – 2
L2	Level closed basin (depression with raised edges).	0 – 2
L3	Level and terraced; not within modern stream channels.	2 – 5
M1m	Moderate-relief rolling, including multi-directional inclined slopes greater than 400 m in length.	6 – 15
M1h	High-relief rolling, including multi-directional inclined slopes greater than 400 m in length.	15 – 30
R2l	Low-relief ridged landscape.	2 – 5
R2m	Moderate-relief ridged landscape.	6 – 15
R2h	High-relief ridged landscape.	12 – 30
SC1-l	Steep-sided valleys with a confined floodplain; low relief.	1 – 9

Code	Definition of Landscape Model	Predominant Slope Range (%)
SC1-h	Steep-sided valleys with a confined floodplain; high relief.	9 – 60
SC2	Incised stream channel in wide valley with one or more terraces.	2 – 60
SC3	V-shaped valley with no terraces or floodplain.	2 – 60
SC4	Intermittently incised subglacial stream channel; partially infilled with glacial deposits.	2 – 60
U1l	Gently undulating or wavy pattern.	0.5 – 2
U1h	Undulating or wavy pattern.	2 – 5
W1	Channels, sloughs and ponds in a linear arrangement.	0 – 1
W2	Sloughs in a non-aligned aggregation.	0 – 1
W3	Level basin that may be filled or partially filled with water. Semi-permanent to permanent water body.	0 – 1

Landscape models sometimes include the following surface form modifiers.

Table 19. Surface Form Modifiern

Surface Form Modifier Code	Description
c	Channeled or rilled due to water erosion. Includes narrow and shallow temporary watercourses. Used when four or more channels occur within a cross-sectional distance of 800 m.
d	Dissected or gullied due to water erosion. Includes narrow to wide deep watercourses that interfere with ground transportation.
e	Eroded pits. Areas with more than 40% blowouts.
n	Concave or basinal water collection areas affected by surface water collection and/or groundwater discharge.
r	Shallow to bedrock. Bedrock is 1 to 5 m below ground surface

9.2.4 LISTING OF SOIL SERIES FOR THE DRY MIXEDGRASS (SCA 1)

Soil series are defined on the basis of detailed features of the soil pedon, such as colour, lithology, texture, and structure. Soil series reflect a unique combination of a soil subgroup and parent material that is present over a representative land area. Soil series are named for geographic points (e.g. towns) located in the area where they occur, and each soil series is denoted with a three-letter symbol. Soil series descriptions include soil subgroup, texture (Fig. 5) and parent material. A change in any of the three properties can result in a new soil series if there is sufficient area mapped in its applicable Soil Correlation Area.

Table 20. Soil Series of SCA 1. Brown Soil Zone (Dry Mixedgrass Natural Subregion)

Soil Order	Soil Subgroup	Parent Material, Surface Expression, Texture															
		Softrock	Till			Lacustrine				Glaciofluvial						Fluvial- Eolian	
			Veneer over softrock	Blanket		Blanket		Veneer over till	Veneer over glacio-fluvial	Fans or flood-plain	Blanket	Veneer over till	Veneer over lacustrine	With gravels		Blanket	Veneer over till
		Medium to mod. coarse	Medium	Mod. fine	Mod. fine to mod. coarse	Fine	Med. to mod. fine	Med to mod fine	Med over v gr and v coarse	Medium	Mod. coarse	Coarse over mod. fine	Coarse over mod. fine	Gravelly very coarse	Very gr and very coarse	Very coarse	Very coarse over mod fine
Chernozem	Orthic	^{Z}Comrey **CMR** Pinhorn **PHN**		^{Y}Maleb **MAB** Masinasin **MSN** Wheiden **WDN**	Foremost **FMT**	Seven Persons **SPS**	Chin **CHN**	Cranford **CFD**	Ramillies **RAM** ^{X}Taber **TAB**	Bunton **BUT**	Bingville **BVL**	Antonio **ANO**	Rainier **RIR**	Kangaroo **KGO**	Pemukan **PUN**	Cavendish **CVD**	Purple Springs **PLS**
	Orthic saline						Lilybrown **LLB**										
	Gleyed						Meachin **MHN**										
	Rego			^{Y}Helmsdale **HMS** Clarinda **CLR**												Vendisant **VST**	
	Calcareous			Travers **TVS**		Acadia Valley **ACV**	Expanse **EXP**										
	Solonetzic			^{W}Ronalaine **ROL** Cecil CCL		Millicent **MCT**	^{W}Chinz **CHZ** Tilley **TIY**	Timko **TIK**									
Solonetz	Solod			Halliday **HDY**		Rosemary **RMR**	Karlsbad **KBD**	Gem **GEM**									
	Solodized Solonetz		Steveville **SIL**	Hemaruka **HUK**		Patricia **PTA**	Wardlow **WDW**	Duchess **DHS**			Youngstown **YTW**	^{V}Gopher **GPH** Sunnynook **SYK**	^{V}Rolling Hills **RHS** Rolward **RRD**			Yarnley **YNY**	
	Solonetz					Stirling **SIG**	Bullpound **BLP**										
Regosol	Orthic									^{U}Orion **ORN** McNab **MCN**					^{T}Etzikom **EZM**	Antelope **ATP**	

Table 20. Soil Series of SCA 1. Brown Soil Zone (Dry Mixedgrass Natural Subregion) continued

Soil Order	Soil Subgroup	Parent Material, Surface Expression, Texture															
		Softrock	Till			Lacustrine						Glaciofluvial				Fluvial- Eolian	
			Veneer over softrock	Blanket		Blanket		Veneer over till	Veneer over glacio-fluvial	Fans or flood-plain	Blanket	Veneer over till	Veneer over lacustrine	With gravels		Blanket	Veneer over till
		Medium to mod. coarse	Medium	Mod. fine	Mod. fine to mod. coarse	Fine	Med. to mod. fine	Med to mod fine	Med over v gr and v coarse	Medium	Mod. coarse	Coarse over mod. fine	Coarse over mod. fine	Gravelly very coarse	Very gr and very coarse	Very coarse	Very coarse over mod fine
	Gleyed saline						Scotfield **SFD**										
	Cumulic									[S]Verdigris **VGR**	Milk River **MKR**						
Gleysol	Orthic						Illing-worth **IWT**										
	Orthic Luvic						Neidpath **NDP**	Skiff **SKF**									
	Rego			Kitsim **KTM**		Walsh **WLH**	Ventre **VET**									Islands **INS**	
	Rego (saline)					Gleddies **GLS**	Dishpan **DHP**										
	Rego Humic						Sloughay **SLY**										
	Humic Luvic						Tempest **TEP**										

[Z]CMR is moderately-coarse textured, and PHN is medium-textured.

[Y]MAB and HMS are north of the Lethbirdge – Etzikom moraine. MSN and CLR and sourth of the moraine. WDN is a fine-textured lacustro-till located in the Oyen area.

[X]TAB is medium-textured lacustrine veneer overlying sands.

[W]ROL and CHZ are Solonetzic Chernozems, and CCL and TIY are former Solodic Chernozems (in older soil surveys), now classified also as Solonetzic Chernozems.

[V]GPH and RRD have a moderately coarse-textured veneer. RHS and SYK have a very coarse veneer.

[U]ORN is sodic and MCN is saline.

[T]EZM is gravelly very coarse.

[S]VGR is moderately fine fluvial.

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